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ART. XXIX.—*Discovery of Additional Remains of Pterosauria, with Descriptions of two new Species;* by Professor O. C. MARSH, of Yale College.

THE first remains of Pterodactyls detected in this country were found in the upper Cretaceous shale of Western Kansas, by the writer, during the explorations of the Yale College party in the autumn of 1870. The specimens then obtained, although very fragmentary, were deemed sufficiently characteristic for determination, and the gigantic species they were believed to represent was briefly described under the name *Pterodactylus Oweni*.* The great interest attached to these remains led to a careful reëxamination of the same region by the Yale party of the following year, and with most gratifying results. An excavation at the point where the first specimens were found yielded further portions of the same skeleton, and, at various localities in the same strata, other specimens were secured, which not only throw much light on the species first discovered, but also prove the existence of two other Pterosaurians, likewise of great size, showing that these peculiar reptiles, so long deemed wanting in America, were apparently well represented here during the later Cretaceous.

Pterodactylus occidentalis Marsh.

The additional remains of this species, discovered by our party during the past summer, consist of portions of five indi-

* This Journal, vol. i, p. 472, June, 1871. As this name had already been applied provisionally by Seeley to a Pterodactyl from the Greensand of England, the present species may be called *Pterodactylus occidentalis*.

viduals, which differed somewhat in size, but all tend to confirm the conclusions based on the fragments first examined. From the locality which furnished one of the original specimens, we recovered the proximal end of the right wing-finger metacarpal, which evidently belonged with the distal extremity described, and proves the entire bone to have been at least fifteen inches in length, or much more elongated than any hitherto known. With this specimen were found portions of the second and third phalanges of the same wing-finger, all indicating the great size and power of the wings. Another specimen, found by the writer at a higher level, in the yellow chalk, pertained to a larger individual, and is of much interest. It consists of the distal extremity of the left-wing metacarpal, articulated to the adjoining proximal end of the first phalanx. Both bones are in excellent preservation, and show this characteristic joint most perfectly.

The most important remains of this species yet discovered, however, consist of nearly all the bones of a right wing, from the humerus to the last phalanx inclusive, which were found by the writer in place in the gray Cretaceous shale, during our investigations near the Smoky River. Although more or less fractured, the bones are in general well preserved, and show clearly the peculiar structure of the Pterosaurian wing, as well as the especial characters that mark the present species.

The humerus, which is nearly perfect, is remarkably short and robust, and in its main features surprisingly bird-like. The articular head is large and crescentic, convex on its anconal face, and concave on the opposite side. Its proximal outline is concave transversely, thus differing widely in this respect from the avian type. The ulnar crest is very prominent, and its proximal extension is continued to the line joining the radial and ulnar angles of the articular head. The radial crest is prominent, but scarcely exceeds the ulnar ridge in size, and is hence proportionally much smaller than in most of the Pterodactyls described. Its point of greatest extension is nearly opposite the distal subsidence of the ulnar crest. There is no pneumatic foramen on the anconal side of the proximal extremity. The shaft of the humerus is smooth, sub-cylindrical in transverse outline, and apparently less sigmoid longitudinally than in the species already known. The osseous walls are thin, and very compact. The distal extremity is much flattened, and has the articular condyles very similar to those in the humerus of birds. The radial condyle is the larger, and more prominent. It is oval in outline, and extends obliquely rather more than half way to the ulnar side. Near its termination on the palmar surface, and on the ulnar side of the median line, is a large, oval, pneumatic foramen. There is here no indication

of an impression for the attachment of the anterior brachial muscle, as in the humerus of birds. The ulnar condyle is transversely oval in form, and is separated from the radial condyle by an oblique groove. The principal dimensions of the humerus are given in the table below.

The fore-arm in the present specimen was composed of two separate bones, which differ much in size. The larger bone was apparently the ulna, and its proximal end covered with its articular faces the greater portion of the condyles of the humerus. The smaller or radial element was closely attached to the larger bone on its front or palmar side. Both of these bones had unfortunately been crushed, and the shafts badly fractured, so that their exact length cannot be accurately ascertained. They were, however, at least thirteen and a half inches long, and probably much more. With exception of the much greater difference of the two bones in size, they appear to resemble most nearly the anti-brachial bones of *Pterodactylus Suevicus*, as figured by Quenstedt.* With the above specimens were exhumed three bones belonging to the wrist; a large proximal carpal, a distal one of nearly equal size, and a third, much smaller, which is probably a lateral carpal. The two larger bones correspond essentially in their main features with those of *Pt. Sedgwickii*, figured by Owen,† although they indicate a superior size for the present species.

The metacarpal of the wing-finger in this series of specimens is represented only by its distal extremity, so that its dimensions must be determined mainly from a comparison with the other specimens pertaining to this species. The part preserved resembles strongly the distal end of the tibia of a bird, but differs essentially in the obliquity of its condyles—which have a sweep of about two thirds of a circle—and in the presence of a large pneumatic foramen on the palmar side, in the depression between the condyles. On the opposite side there is no indication of a similar opening. There was also, apparently, no median rising in the groove of the distal end, either in the present specimen, or in others of the same species. The outer trochlear surface is most developed, and has its exterior margin angular. In its proximal extension on the palmar side, it bends outward, and terminates in an obtuse lateral tubercle, which forms, on its articular surface, nearly a right angle with the side of the adjoining shaft. The inner trochlear surface has a rounded interior margin, and, on the anconal side, ends abruptly in a prominent ridge, which limits the lateral motion of the joint.

There were four phalanges in the wing-finger, and the greater portion of all of them is preserved. The first phalanx is almost

* Ueber *Pterodactylus Suevicus*, 4to, Tübingen, 1855.

† Fossil Reptilia from Cretaceous, Third Supplement, pl. iv.

entire, and measures about seventeen inches in length. Its proximal end presents the peculiar articulation for union with the metacarpal, which is well shown in the figures given by Quenstedt, von Meyer and Seeley. The outer articular face, or that on the ulnar side, is broad, nearly flat transversely, and forms almost a right angle with the adjoining side of the shaft. The inner face is shorter, deeply concave transversely, with a thin exterior edge. The two articular faces converge, and unite on a sub-triangular olecranoid process, which projects proximally from the anconal side of the shaft, thus moving between the condyles of the adjoining metacarpal, and preventing the flexure of the joint beyond the full extension of the wing. On the opposite side, between the articular faces, there is a deep groove, which is continued some distance distally. It apparently contains a large pneumatic foramen. The distal end of this bone presents an elliptical, convex, articular face, which does not entirely cover the distal surface. The second phalanx has its proximal extremity adapted to this articular face by a shallow elliptical cup, which does not extend over the most proximal portion of the extremity. The distal end resembles in everything but size the corresponding part of the first phalanx. The next or third phalanx is quite similar to that which precedes it, except that it is more attenuated. The slender terminal phalanx appears to have been more nearly circular at its proximal end, although apparently compressed toward its other extremity. The articular surfaces of all the bones preserved are smooth and well defined, like those of mammals and birds. All the bones of the wing, moreover, even the carpals, appear to have been pneumatic.

The teeth found with remains of this species, and supposed to belong with them, are very similar to the teeth of Pterodactyls from the Cretaceous of England. They are smooth, compressed, elliptical in transverse outline, pointed at the apex, and somewhat curved.

The following are the principal dimensions of the specimens mentioned in the previous description. Some of the measurements are only approximately correct, owing to the distortion by pressure of several of the specimens:

Measurements.

Length of humerus on radial side,	163· mm.
Length on ulnar side,	174·
Greatest diameter of articular head,	38·
Least diameter of articular head,	12·
Greatest diameter or width of proximal end,	63·
Greatest diameter of distal end,	64·
Vertical diameter of shaft, where least,	29·
Length (minimum) of ulna, or larger bone of fore-arm,	336·

Greatest diameter at proximal end,	48· mm.
Greatest diameter of articular surface,	46·
Greatest diameter of distal end,	42·
Greatest diameter of radius, at proximal end,	33·
Greatest diameter at distal end,	28·
Transverse diameter of proximal carpal,	51·
Antero-posterior diameter of proximal carpal,	28·
Greatest diameter of articular face of distal carpal,	42·
Length of lateral carpal,	24·
Length (minimum) of metacarpal of wing-finger,	412·
Length of first phalanx of wing-finger,	428·
Transverse diameter of proximal end,	53·
Chord of greater articular surface,	30·
Length of olecranoid process,	20·
Greatest diameter of distal end,	29·
Greatest diameter of distal articular surface,	35·
Least diameter,	8·
Greatest diameter of second phalanx, at proximal end,	35·
Greatest diameter of proximal articulation,	28·
Greatest diameter of distal articulation,	20·
Least diameter,	6·
Greatest diameter of proximal articulation of third phalanx,	18·
Least diameter,	7·
Greatest diameter of proximal articulation of fourth phalanx,	10·
Length of crown of tooth,	25·
Antero-posterior diameter at base,	9·
Transverse diameter at base,	5·5

The above measurements of the wing-bones would indicate for the entire wing a length of at least eight and a half feet, and, for the full expanse of both wings, a distance of eighteen to twenty feet. The present species, therefore, contains some of the largest "flying dragons" yet discovered. Its main distinctive features are readily seen in the very short and stout bird-like humerus, with its moderate radial crest, and large distal pneumatic foramen; in the separate radius and ulna, differing greatly in size; and in the extremely elongated wing-metacarpal. The latter character renders it almost certain that the species belonged to the short-tailed or true Pterodactyls, as in the other groups this bone has been found to be invariably less than one-half the length of the fore-arm. The large laniary teeth clearly indicate the carnivorous and predacious habits of the species, and its food was doubtless fishes, which it captured probably by plunging into the water, like the Pelicans and other similar birds.

All the known remains of this species were found in the upper Cretaceous strata, near the Smoky River in Western Kansas.

Pterodactylus ingens, sp. nov.

The existence of a second and much larger species of Pterodactyl, in the same strata with the remains just described, is clearly indicated by a number of specimens, pertaining to four individuals, which were discovered last summer during the explorations of the Yale party along the Smoky River and its tributaries. One series of these specimens consists of the greater portion of an ulna, part of a radius, the distal end of a wing-metacarpal, and portions of the corresponding phalanges, evidently belonging to the right wing of the same animal The other specimens secured are equally characteristic, and serve to supplement this series.

A comparison of these various remains, especially the bones of the fore-arm, with the corresponding parts of the preceding species, shows several important differences, aside from that of size. In the former species, the ulna, or larger anti-brachial bone, has, on its proximal end, two large articular faces for union with the condyles of the humerus, and between them a low elevation, which extends only to a line joining the proximal margins of these surfaces. In the large species, this elevation is represented by a very prominent, flattened protuberance, which projects far beyond the rest of the proximal extremity. The smaller articular face in this specimen, moreover, is much less inclined from the axis of the shaft. The distal ends of the same bones show equally marked differences. In *Pt. occidentalis*, the articular face on the outer side extends transversely only to the margin of the central tubercle. In the species under consideration, this face does not terminate until it reaches a point opposite the middle of the corresponding projection, which is much more compressed than in the smaller specimen. The radii, also, of the two species exhibit essential differences, especially in their proximal extremities.

The metacarpal bone of the wing-finger is very similar at its distal end to that of the species above described. It shows, however, unmistakable indications of a median ridge on its anconal side; and since this is also the case with all the other specimens preserved, there can be little doubt that this feature was a specific character. The remaining portions of the phalanges, so far as the present material allows of comparison, show no essential differences in the two species.

With one series of the above specimens, a small bone was found, which is probably the distal end of a metatarsal. In its general features it agrees most nearly with the bone figured by Seeley as a metacarpal or metatarsal.* The fact that this specimen is nearly solid bone would be an argument for considering

* Ornithosauria, plate vi., figures 8 and 9.

it the latter, as all the wing-bones examined during the present investigation are clearly pneumatic.

The dental characters of this species are at present only known from a single crown of a tooth, found with one series of the specimens, and from two larger and very perfect teeth found by themselves, which agree so closely with the former that they deserve notice in this connection. These specimens are less curved and less compressed than the teeth referred to *Pt. occidentalis*, but in other respects they are nearly identical.

Measurements.

	mm.
Greatest diameter of ulna, at proximal end,	67·
Greatest diameter, at distal end,	68·
Greatest diameter of radius, at proximal end,	44·
Transverse diameter of wing-metacarpal, at distal end,	38·75
Transverse diameter of shaft, at junction with condyles,	32·
Antero-posterior extent of outer condyle, on palmar side,	34·
Antero-posterior extent of inner condyle, on palmar side,	35·
Transverse diameter of proximal end of first wing-phalanx,	41·
Length of olecranoid process beyond outer articular face,	32·5
Transverse diameter of supposed metatarsal, at distal end,	14·
Length of crown of small tooth found with above remains,	18·6
Antero-posterior diameter, at base of crown,	7·25
Transverse diameter,	5·
Length of large isolated tooth,	48·
Antero-posterior diameter at base of crown,	14·
Transverse diameter,	11·3

The present species was evidently one of the most gigantic of Pterosaurs. It was at least double the bulk of *Pterodactylus occidentalis*, and probably measured between the tips of the fully expanded wings nearly twenty-two feet!

The various remains on which the species is based were discovered, in July last, by Lieut. J. H. Whitten, U. S. A., Mr. O. Harger, of Yale College, and the writer. The localities were in the blue shale and yellow chalk of the Upper Cretaceous, near the Smoky River, in Western Kansas.

Pterodactylus velox, sp. nov.

This species, which was apparently about two thirds the size of *Pterodactylus occidentalis*, is at present represented, so far as known, by the distal end of a right metacarpal of the wing-finger, and by the proximal extremity of the adjoining first phalanx. These bones, however, are among the most characteristic parts of the Pterosaurian skeleton, and in the present instance the specimens appear to show several points of distinction from the species already described.

In the metacarpal bone, the articular distal extremity is smaller in proportion to the size of the shaft which supports it, than in either of the species above described. In other respects

it appears to present no essential difference except that of size. The first phalanx, however, shows in its proximal end several differences which are clearly of specific importance. The outer articular surface in the present specimen is proportionally much narrower, and has its posterior margin more extended proximally. There is, moreover, no indication, on the inner side of the bone, of the large obtuse tubercle which is a prominent feature in all the corresponding specimens of the other two species. The epiphysis which bears the olecranoid process has disappeared from the present specimen, leaving an elongated oval depression, with a well defined margin. Both of the above bones are somewhat distorted by pressure.

Measurements.

Transverse diameter of wing-metacarpal, at distal end,	26· mm.
Proximal extent of outer condyle, on palmar side,	22·6
Proximal extent of inner condyle,	20·
Transverse diameter of shaft at junction with condyles,	21·
Antero-posterior diameter of proximal end of first phalanx,	38·
Greatest transverse diameter,	12·

The specimens of this species at present known do not afford perfectly reliable data for estimating the size of the animal, but the wings, when fully expanded, were probably from twelve to fifteen feet in extent. The fossils here described were found by the writer, in July last, in the gray cretaceous shale, on the south side of the Smoky River, in Kansas.

Yale College, New Haven, Conn., Feb. 26th, 1872.

ART. XXX.—*On a new method of measuring the Velocity of Rotation;* by Prof. A. E. DOLBEAR.

WHILE experimenting with the gyroscope, I have often wished to know its velocity, but knew of no way to determine it when it was set in motion in the usual way with a string. I have lately found a simple and exact way of doing this, and a description of the plan may be of interest to others, as it can be used to measure the velocity of wheels of every size, and every possible speed, without inconvenience and without expense.

If a short piece of wire be soldered to the end of one branch of a common tuning fork, one end of the wire projecting a little on one side, and the fork made to vibrate at the same time that the point of the wire is drawn over a piece of smoked glass, an undulating line is made, and if the rate of vibration of the fork is known, the velocity of the moving hand can be found by counting the number of undulations in an inch on the glass. This has been used to determine linear velocity; but it can also be applied to rotary with great precision. I have a large fork

with branches eight inches in length that vibrates one hundred and seventy-one times in a second as determined by a resonant tube; it has copper wire fastened to one branch and projecting about one-fourth of an inch,—made for showing to a class the waving line upon smoked glass. A brass disk four inches in diameter, mounted gyroscopically, was smoked upon one side and set revolving by a string. The vibrating fork was then brought to it in such a manner that its vibrations were along the radius of the disk, but as soon as it touched it bounded away and nothing could be determined with it. A *cone of india rubber*, about a quarter of an inch in height, was then fastened with sealing wax near one end of the branch, and this tried as before with entirely satisfactory results, the markings being well defined and unmistakable.

When the number of vibrations the fork makes a second is known, and the number of undulations made once round the disk, the former number divided by the latter will give the rate per second of velocity. Thus if the fork made 100 vibrations in a second and the disk turned round but once in the same time, it is evident that there would be a hundred undulations on it, and if the disk turned 50 times a second, there would be but two undulations for each revolution. In any case, if a equals the number of vibrations per second of the fork, and b equals the observed number of undulations in a single turn of the disk, then $V=\frac{a}{b}$.

A single wave, or even half of one, is sufficient for determination if the length be measured in degrees, in which case if $d =$ the length of one wave in degrees, the formula will stand $V=\frac{ad}{360}$. If the rotation be very rapid the quickest possible touch is needed or the undulations will return and confuse each other; but this is not troublesome at any speed I have been able to obtain, which is in the neighborhood of 90 per second.

I have found that a common pocket tuning fork, either an A or a C, answers very nicely with one of india rubber fastened as before. So far as I now know, the swiftest motion that has been given to a disk was that in Foucault's apparatus for showing the motion of the earth which he estimated at from 150 to 200 revolutions per second. Such a velocity would be recorded by from 2 to 3 undulations of a C fork, making 512 vibrations per second. If it would not be best to smoke the disk, a piece of white paper can be pasted upon it and smoked without burning, and it answers every purpose. To the certainty and ease of this method may be added another advantage, that the slightest touch needed for this cannot sensibly retard the motion of the disk, as any mechanical fixture attached for such a purpose must do.

Physical Laboratory, Bethany College, Bethany, W. Va., January 19.

ART. XXXI.—*Green Mountain Geology. On the Quartzite;* by JAMES D. DANA.

(Continued from page 186).

2. QUARTZITE OF POUGHQUAG, DUTCHESS CO., N. Y.

THE town of Poughquag is situated on the road from Pawling (a village on the Harlem railroad) to Poughkeepsie, and is about five and a half miles northwest of Pawling,* near the parallel of 41° 38′.

In order to arrive at the true relations of the Poughquag quartzite, the position and age of the other rocks of the region must be considered.

1. *Taconic rocks.*—As has been stated (p. 184 of this volume) the Stockbridge limestone extends from Canaan, west of south, through Dover to Pawling. It continues beyond this latter place southward along the valley, for seven or eight miles, where both valley and limestone narrow out.†

In the region of Pawling the limestone dips to the eastward at a large angle, between 55° and 70°; and in the two and a half miles of breadth there must be a thickness of at least 3,000 feet, perhaps of 5,000 feet. Supposing that there are no folds—none were detected by us—the thickness would be much greater than this.

West of the Pawling limestone region to Poughkeepsie on the Hudson,—a distance of twenty-one miles, directly across the strikes—the rocks all the way, with some small local exceptions, dip *easterly* (to the south of east) the observations of Mr. Gardner and myself thus confirming those published in Professor Mather's New York Geological Report. This region of easterly dip continues eastward of Pawling to within three miles‡ of New Milford (on the Housatonic), or twenty-seven miles from Poughkeepsie.

Leaving Pawling on the way to Poughquag, going northwestward, you pass from the Stockbridge limestone (of Pawling) to

* The distances given in this paper are air-line, not road-line, distances.

† I am not yet able to say which of the patches of limestone to the south of this apparent termination is a continuation of the Stockbridge limestone, or that any is so. The abrupt ending of the beds is undoubtedly due to the presence of the Azoic Highland ridges on the west and south, alluded to beyond. The areas about Williamsburg and along the Harlem railroad are probably continuations, not of the Stockbridge band, but of other bands of limestone lying farther to the east—those of Kent and New Milford (see Percival's map, in his Geological Report); which, by the way, according to sections made by Mr. Gardner and myself, in the line of New Milford, and to the north, are opposite sides of a synclinal, and which, with the superincumbent gneisses and schists, overlie the Stockbridge limestone, unless a great fault intervenes.

‡ The position of the synclinal axis referred to in the preceding note.

mica schist, part of it gneissoid; and this schist unquestionably *underlies conformably the limestone*. Along the plane of junction of the limestone and schist, both here and to the north, occur beds of limonite, which are a result of the alteration of iron-bearing minerals in the schist, as stated by Percival, the beds often retaining in some parts the structure of the schist.* The strike of the schist is N. 10°–40° E., and the dip about 50° to the eastward. It is a southern extension, as recognized by Percival, of the schist or slate of Taconic mountain. It has the same lithological characters as the rocks of Mt. Washington, the principal elevation of that range, which is situated in Massachusetts but on the borders of Connecticut, and spreads west into New York. The rock passes in some places into what has been called *talcoid schist*, or a smooth fine-grained mica schist, somewhat greasy in feel;† it is often chloritic, and in Salisbury and some parts of Mt. Washington, as Percival states, contains staurolite. Quartz seams and veins are common in many parts, and nests of chlorite occur occasionally in the quartz.‡

The same rock occurs also in Graylock, near Williamstown, Mass., which may be looked upon as a northern part of the range; and even a chloritic variety occurs in the Graylock region. It is not an irrelevant fact that the schist of Mt. Mansfield, Vermont, is a very similar mica schist to that of Graylock, and that on the highest point of this mountain I broke off a piece of chloritic mica schist not distinguishable lithologically from a specimen I collected from one of the ridges on the ascent of Graylock.

About a mile and a half southeast of Poughquag (and four from Pawling) the mica schist is left for a *light-gray fine-grained thick-bedded gneiss*, partly granitoid. The gneiss has essentially the same strike and dip as the overlying mica schist, the strike being N. 10°–35° E., and the dip mostly 50° to 60° to the

*Specimens collected by Mr. Charles A. Brinley at Richmond, Mass. show that the principal one of the minerals there altered to limonite is siderite (spathic iron or carbonate of iron). The limestone in some limonite localities is the *underlying* rock.

†The *talcose schists* of early writers on the Taconic rocks and other schistose strata, or *magnesian slates* of Emmons, are shown in the Vermont Geological Report (p. 425) to be mainly a very fine grained mica schist, in which the mica is more or less hydrous; and the term *talcoid schist* is used for it. Although looking and feeling like a talcose schist, it contains only a per cent or two of magnesia. Prof. T. Sterry Hunt has confirmed this conclusion in his study of both Vermont and Canada rocks.

‡I have examined the rocks of Taconic Mountain myself only in Mt. Washington. Percival, in his Geological Report of Connecticut, describes the rock of "Taconic Mountain" as fine-grained micaceous or talcose-micaceous schist, containing garnet and staurolite. He adds, "Sometimes it is greenish and sub-chloritic, with seams and patches of compact green chlorite, and yet accompanied with the same minerals [garnets and staurolites]. This is particularly the case in the south and northeast part of Taconic Mountain."

eastward. *This gneiss is, therefore, conformable to the schist, and an inferior bed of the Taconic series.*

2. *Poughquag and more western limestones.*—West of this gneiss, about Poughquag, there is a great limestone formation, which, judging from the width of the area and its dip, is as thick as that at Pawling. It has the same strike with that rock, or N. 30°–40° E., with the dip also about the same, or 40° to 60° to the southeastward. This range of limestone extends northward, and although interrupted for some distance, appears to be the same with that which Percival and Mather lay down as passing through eastern Washington, western Amenia, Boston Corners, by the east side of Winchell's Mountain (a ridge just southwest of Boston Corners), to Copake on the east side of Ancram Creek valley. It is distinct, according to Mather, from another limestone range in Copake, which lies on the *west* of Ancram Creek valley, and stretches south on the west of Winchell's Mountain to Pine Plains and Stissing, and thence, by Wappinger Creek valley, to Barnegat on the Hudson—a range of limestone called by Mather the *Barnegat* limestone. Mather speaks of another intermediate line, extending from Stamford, through Washington, and half a mile east of Verbank; and this line appears again at Arthursburg and Beekman, and continues down Fishkill Creek to Matteawan on the Hudson.*

Calling the Pawling (or Stockbridge) limestone No. I, the Poughquag and eastern Copake is No. II; the Arthursburg and Fishkill Creek, No. III; the western Copake, Pine Plains, Stissing and Barnegat (Barnegat limestone), No. IV.

In an excursion to Poughkeepsie, we passed No. III at Arthursburg, ten miles from Poughkeepsie, and No. IV, or the Barnegat limestone, at Manchester, three miles from Poughkeepsie. Barnegat is a place on the Hudson, about four miles below Poughkeepsie.

The limestones in Nos. III and IV may in many places be seen to be underlaid and overlaid by clay-slate, the prevailing rock of the region from the meridian of Poughquag to the Hudson River.† Whether the four ranges of limestone differ in age is not yet ascertained. Faults undoubtedly occur over the region, so that the uniform easterly dip is no proof that the western strata are the older. The folds in the slates sup-

* Mather has an obvious error in his statements about this band and the first of the bands here mentioned; for he makes the first to extend to Fishkill, and the one last mentioned to *cross* that and extend to Poughquag. The great bands of limestone are not continuous lines, owing probably to the irregular manner in which the rocks have been faulted and the subjacent slates uplifted; but the parts of each have a nearly common direction. The region requires a careful survey.

† With the slate there are extensive beds also of compact slate-rock or argillaceous sandstone.

posed to exist there by the Professors Rogers we found no certain proof of, but were rather disposed to believe in a series of faults and monoclinal uplifts.

The Poughquag limestone is bluish and less perfectly crystalline than the Pawling; and, both the limestones and the slates show a *continued diminution in the degree of metamorphic changes as you go farther west.* The Barnegat is very slightly crystalline, and evidently contains fossils, as has been reported, although none have yet been found that could be determined; and the slates pass from micaceous or talcoid schists to simply glistening slates, and in some places to earthy slates, which are almost shales.

The question is especially important here, whether the Poughquag limestone (No. II) is older than the Pawling (Stockbridge), or whether it is the same rock, separated from the Pawling by a fault along the eastern side of the Poughquag limestone, accompanied by an uplift carrying upward the mica schist and the subjacent gneiss. The existence of such a fault was strongly suspected both by Mr. Gardner and myself, on the ground of the nearly equal extent of the Poughquag and Pawling limestones; and it further seemed probable that this fault and the uplift were but a southern portion of a north and south series of similar faults and uplifts, which resulted in the making of Mt. Washington and the rest of the Taconic range; these elevations, like the elevated gneiss near Poughquag, stand along the *east* side of this supposed line of fault. Gneiss is only an occasional rock as far west as Poughquag, and wherever it occurs among the schists and clay-slate it appears to be evidence of a great uplift. The identity of the two limestones is also favored by the fact that limonite beds occur in Amenia between the limestone range No. II and the underlying schist, just as they do in Pawling between No. I and the underlying schist.

3. *Archæan rocks.*—Besides the limestones and Taconic schists and gneiss, there is, near Poughquag, in still more intimate connection with the quartzite, rocks of the Azoic age, a continuation of the Highland range of New Jersey—a range recognized as Azoic first by H. D. Rogers, and shown to continue into Dutchess county by Logan and Hall (this Journal, II, xxxix, 96). They are probably Laurentian, as stated by Logan and Hall, that is, they are equivalents of the oldest known Azoic rocks of Canada. But as this point is not definitely settled, and since the term Azoic has been ruled out by facts proving that the era was not throughout destitute of life, I propose to use for the Azoic era and its rocks the general term *Archæan* (or Arche'an), from the Greek *ἀρχαιος, pertaining to the beginning.**

* Whatever part of the Archæan beds are proved to belong to an era in which there was life, will be appropriately styled the *Archeozoic.* This term avoids the objection which Eozoic derives from the doubtful nature of the Eozoum.

These Archæan rocks of the Highland range are exposed to view in a deep cut on the unfinished Hartford & Fishkill Railroad, within a mile of Poughquag. The light-gray gneiss east of Poughquag, above referred to, lies to the north of the stage-road; while 300 or 400 yards to the south of it, and in sight from it, there is a high railroad embankment, leading westward into the cut. The Archæan rock is a coarsely crystallized gneiss, containing red orthoclase (feldspar), some white albite (or possibly oligoclase), and in places a little hornblende, with a few spots of magnetic iron. Some portions were a blackish gneiss. The strike is N. 40°–55° E.; the dip is nearly vertical, but varies from 65° to the southeastward, to 80° to the northwestward, while mostly 70° to 80° to the southeastward. This gneiss was thus wholly unconformable to that before described, and also widely different in its lithological characters. Some layers of it at Brewster, fifteen miles to the east of south, on the Harlem railroad, contain zircons and are really a zircon syenite; but they alternate with others that are simply gneiss. A bed of magnetic iron ore is worked in the vicinity of Brewster.

It should be here stated that the lithological distinction of this Laurentian area in Dutchess county was first noticed by Percival, who defines it on his map, and numbers it K 3. The locality above described is situated at the very extremity of his area K 3.

4. *Quartzite formation.*—The quartzite constitutes a northeast and southwest ridge on the west side of the Archæan range, the two being parts of the same elevated region. The height of the ridge is by estimate two or three hundred feet above the Poughquag plain. The railroad track, after leaving the Archæan cut, enters a deep cut through the quartzite. The latter rock appears to rest in nearly horizontal layers on the flanks of the Archæan or Laurentian ridge. The contact of the two is not in sight; but only sixty to seventy yards intervene between their nearest outcrops, and the small valley along the junction is just such as usually occurs when two meeting rocks are of unequal hardness.

The quartzite is in general evenly bedded. While there are hard compact layers, many are very thin and friable, looking sometimes as if argillaceous, though really consisting of fine quartz sand. This finer kind is often a little silvery, with micaceous or talcoid scales, and sometimes contains traces of chlorite. The stratification varies but little from horizontality, and the variations are in large undulations toward different points of the compass, the dip being mostly but 5° or 10°, though sometimes 15°. There is hence *no conformability to the Archæan gneiss, and none to the gneiss, mica schist, or limestone, of the*

Taconic series. The nearly horizontal beds of quartzite lie on the nearly vertical Archæan, and both occur within a few hundred yards of the steeply inclined Taconic beds. The rocks are sparingly faulted; but in some narrow vertical sections this faulting has been carried so far as to obliterate the stratification; a case of this kind is represented in the figure on page 182.

5. *Relation of the Quartzite to the Poughquag limestone adjoining it.*—At the west end of the cut we open upon the plain of Poughquag, and come immediately to the Poughquag limestone (No. II). There is no section exhibiting the quartzite and limestone together; yet it is obvious that the quartz is the inferior rock, and that the two are unconformable.. Outcrops of the two occur within 200 yards of one another and on the same level; and while the quartzite is nearly horizontal in these outcrops as elsewhere, the limestone in the nearest exposure has a strike of N. 45° to 50° E., with a dip to the northwest of 40° to 45°; showing not only unconformability to the quartzite, but also a wide divergence from its ordinary dip in the region, which is 40° to 50° to the eastward.

The Poughquag limestone continues westward for two miles, and becomes to the west interstratified with the glistening clay-slate of the region, the rock which is the prevalent one all the way to the Hudson, fifteen miles. In this clay-slate, there are intercalations of limestone, as has been already stated, but *none of quartzite.*

6. *Conclusions.*—The conclusions that appear to be sustained by the observations are:

1. That the quartzite is older than the Poughquag limestone, and was consolidated and jointed before the deposition of the latter.

2. That the quartzite is older than the rocks of the Taconic beds that outcrop between Poughquag and Pawling, and unconformable to them. For (1) the two are widely diverse in position; (2) beds of quartzite are nowhere found intercalated among the Taconic beds, or overlying them; and (3) the Taconic beds are not found underlying the quartzite between it and the Archæan rocks, but each is wholly independent in all respects of the other, although in so close proximity.

3. That the Archæan or Highland ridges of Dutchess and Putnam Counties, N. Y., were Green Mountain heights standing in the sea in which the sands of the quartzite were accumulated; for (1) the beds of quartzite rest unconformably on the Archæan rocks, and (2) their sands were evidently sea shore or sand-flat depositions. [The heights were probably the southern extremity of a range of Archæan ridges, now lying underneath the Green Mountain formations, the origin of which was the

initial step in the making of these mountains, and the position of which modified the action of the causes depositing later beds, and also, by their unyielding nature or resistance, the action of forces uplifting them.]

4. That, *either* the quartzite was a ledge within or along the shores of the sea in which the limestone was deposited, the two being unconformable and no intermediate beds being present; *or else* there is a fault between the quartzite and limestone, along which the Archæan rocks (overlaid by the quartzite) were brought up to their present position so as to be on a level with the limestone beds.

The latter view is favored by the fact that the line of this supposed fault nearly accords with that to the north between the limestone and Taconic gneiss. The former view is supported by the facts that (1) the Taconic slates, schist or gneiss, which ought to have been carried up on top of the Archæan rocks and quartzite, in case of such a fault or uplift on its east side, nowhere exist in the vicinity of Poughquag, and are not known to the south, along the Highland range. It is in its favor (2) that the irregular or westward dip of the limestone where it borders on the quartzite, although a possible result along a fault, is such as might naturally have arisen from pressure during a period of uplift against a resisting ridge like that of the Archæan; and (3) that a similar contact of limestone and quartzite exists in the Canaan region (p. 183 of this volume) which cannot be due to faulting, since the knolls and ledges of quartzite stand isolated in the limestone area, so that faults adequate to produce their present position, cutting around the irregular areas, are not supposable. The facts which I propose to communicate in a continuation of this paper may throw some light on this doubtful point.

5. That the clay-slates which directly underlie the Poughquag limestone on the west, having a thickness of at least 10,000 feet, probably represent the mica schists west of the Pawling (Stockbridge) limestone, and therefore have the same relation to the limestone and the quartzite.

It is a remarkable fact that in this Poughquag region no beds intervene between the Archæan and the quartzite, although some pre-Silurian strata might reasonably be looked for, and none between the quartzite and the limestone, although so great a thickness of strata really exists in the vicinity inferior to the limestone.

ART. XXXII.—*Descriptions of two new star-fishes, and a Crinoid, from the Cincinnati group of Ohio and Indiana;* by F. B. MEEK.*

PALÆASTER? DYERI Meek.

AMONG the specimens loaned to me for study and description by Mr. Dyer, there is a very imperfect example of one of the largest known Silurian star-fishes. When entire, it must have been from five to five and a half inches in diameter across from end to end of the rays of opposite sides; while its disc, as seen in a flattened condition, measures about two inches in diameter. As near as can be determined from the published description of *Palæaster granulosa* of Hall (which has not yet been figured), this very large specimen would seem to be related to that species, and may possibly be the same. Still, from its much larger size (*P. granulosa* being described as "of medium size"), as well as from the want of exact conformity of some of its details of structure, I am led to believe it distinct. The specimen, however, is unfortunately much obscured by the adhering matrix, and detached and confusedly mingled spines. Like *P. granulosa*, it has the dorsal side composed of numerous small pieces, bearing very small short spines.† These pieces, however, are not, as described in that species, "tuberculose," but merely convex, while the dorsal pores passing through the sutures between them, are apparently so large that the pieces only seem to connect with each other by a few salient points, so as to form a kind of reticulated structure; a feature not mentioned in *P. granulosa*.

Again, while agreeing with that species in having its marginal and adambulacral piece convex, small, tuberculose or coarsely granular, as wide as long, and alternately arranged, it apparently presents the important difference of having very nearly the same number of pieces in each of these ranges, instead of nearly twice as many in the inner as in the outer range. It likewise shows indications of a few disc plates intercalated, on the ventral side, between the marginal range and the inner adambulacral pieces in the only axillary space of that side exposed; which character, if it really exists, would separate it perhaps generically from *P. granulosa*. A comparison of better specimens would probably also show other differences.

Each piece, on the ventral side, shows a small central pit for

* Figures and descriptions of these fossils are to appear in the Ohio Geological Report.

† The spines are articulated, and not merely projecting points of the dorsal pieces themselves.

the articulation of a spine, measuring from 0·16 to 0·23 inch in length, and about 0·04 inch in thickness, and consequently, distinctly larger than those of the dorsal side. On the dorsal side, the so-called madreporiform body can be seen near the margin of the disc, in one of the axils between two of the ranges. It is nearly flat, of a transversely suboval or subtrilobate form, the lobed side being directed inward; while the little divisions are seen radiating and bifurcating inward on the middle lobe, and laterally on the lateral ones, like the nerves of the pinules in some kinds of ferns.

From some of the characters imperfectly seen in the species, it is possible that better specimens may show it to belong to the genus *Petraster*, and render it necessary to write its name *Petraster Dyeri*. The structure of the dorsal side of *Petraster* is, I believe, not certainly known. In the published species of *Palæaster*, the dorsal pieces are illustrated as if close-fitting, or at least without very obvious pores passing between the pieces. Indeed, it was originally supposed that the dorsal pores passed *through these pieces*, instead of through the sutures between them, and this was mentioned in the generic description as one of its most important characters. I have no typical examples of that genus at hand, showing the dorsal side; but as no such characters are shown in the figures of any of the published species, or alluded to in connection with the genus, in later publications, we may perhaps infer that it would not now be insisted upon as an essential character of the genus.

Locality and position.—Cincinnati group of the lower Silurian; from the horizon of about one hundred feet below the tops of the hills at Cincinnati, Ohio; where it was discovered by Mr. C. B. Dyer, to whom I have dedicated the species.

Stenaster grandis Meek.

Attaining a very large size, with the body or disc comparatively small, or only of the breadth of the united inner ends of the five rays. Rays long, slender, gradually tapering, and very flexible, widest at their immediate connection with the body, where they seem to be more or less depressed, but becoming more nearly terete farther out. Dorsal side of body and arms composed of numerous subtrigonal pieces that rise into pointed tubercles, or sometimes assume almost the character of short spinules, and are arranged in quincunx, so as to form about eight rows near the middle of the rays; those of the outer two rows being a little larger than the others. Dorsal pores apparently rather large, and passing through between the concave sides of contiguous pieces. Ventral side of body unknown. That of the rays composed of the usual single row of transverse adambulacral pieces on each side of the well defined,

rather deep, and moderately wide ambulacral furrows. Adambulacral pieces rather more than twice as long as wide, with their longer diameters at right angles to the ambulacral furrows, and rounding over from end to end so as to be most prominent in the middle; while they do not connect with each other by flat sides, but have little projecting processes, and corresponding sinuses, apparently for the purpose of imparting greater flexibility to the rays.

Breadth of body, 0·63 inch; length of rays, 2·40 inches; breadth of same at their connections with the body, 0·36 inch. Diameter across from the tips of rays on opposite sides, about 5·50 inches.

Not having seen the under side of the body of this species, I am not quite sure that it is exactly congeneric with Mr. Billing's typical species of *Stenaster*. It does not show the peculiar contraction of the inner ends of the rays, seen in his *S. Salteri*, from which it also differs in a marked degree in the much greater length and slenderness of its rays. In these characters, however, it agrees more nearly with his *S. pulchellus* and *S. Huxleyi*; though it differs from the first specifically, in having proportionally larger rays, with more numerous dorsal pieces, and in attaining a much larger size. I had suspected that it might possibly be the *S. Huxleyi*, but on comparing drawings, and the foregoing description, sent to him for that purpose, with his typical specimen of *S. Huxleyi*, Mr. Billings writes that he has no doubt whatever that it is entirely distinct.

The specimen shows a few short spines connected with the adambulacral pieces; but neither their exact mode of attachment, nor their arrangement, can be very clearly made out. They seem, however, to connect with these pieces along their joining edges, instead of springing from their crests.

Adopting the suggestion already made by another, that the name *Stenaster* for this group should be replaced by McCoy's name, *Urastrella*, previously suggested, incidentally, for apparently congeneric forms, the name of the species here described would become *Urastrella grandis*.

Locality and position.—Upper part of the Cincinnati group at Richmond, Indiana. I am under obligations to Mrs. M. P. Haines of Richmond, for the use of the only specimen I have seen of this species, which was discovered by her at that place, some time back. It may not be out of place to state here, that this lady has by her own zeal and industry, stimulated by a taste for scientific studies, succeeded in getting together one of the finest and most valuable private collections of minerals and fossils in the West.

GLYPTOCRINUS BAERI Meek.

Body of about medium size, globose-obconoidal. Sub-basal pieces apparently not developed, or very small.* Basal pieces short and pentagonal. First primary radials of comparatively moderate size, presenting a general pentagonal outline; second a little narrower than the first, but of nearly the same length, with a general heptagonal outline; third a little narrower than the first, but of nearly the same length, with a general pentagonal form. Secondary radials, consisting of about four pieces in succession, on each upper sloping side of each third primary radial; the first two or three of each series only about one-third smaller than the second primary radials, while above these the succeeding pieces soon become much shorter free brachials. Interradial pieces numerous, small, of very unequal size, and without any regularity of arrangement. Anal series unknown, but probably consisting of a mesial series of hexagonal pieces resting one upon another, and a greater number of much smaller pieces irregularly arranged on each side. Axillary spaces each occupied by some six or more very small pieces.

Arms ten, rather long, simple, widest a little above their bases, and thence gradually tapering to their ends; composed of very short pieces, so strongly cuneiform as to appear almost to taper to nothing alternately on opposite sides, while each supports a pinnule at its thicker end, along the inner margins. Pinnules very long, moderately short, nearly in contact, and composed of pieces three to four times as long as wide. Surface of body plates without costæ or striæ; those of the primary and secondary radial series more prominent than the much smaller pieces filling the interradial spaces, and thus forming somewhat flattened ridges, more or less interrupted at the sutures, and abruptly beveled at the sides; interradial and axillary areas roughened by a minute projecting central point on each of the little pieces filling them.

Column of moderate thickness, apparently nearly round, or perhaps sub-pentagonal near the base, and composed of alternately thicker and thinner pieces, the former of which project a little beyond the others.

The body of the only specimens of this species I have seen, are too much distorted by pressure to afford accurate measurements, but it seems to have been about 0·45 inch in height, by

* I prefer to designate the minute pieces sometimes seen at the connection of the body and column, in species of this and some other Silurian types, as sub-basal pieces, rather than as true basals, not only because they are sometimes absent in species of the same genera, but because precisely similar pieces are sometimes intercalated between the segments of the column, in the types in which they occur, for some distance below the body, thus indicating that they belong to the column.

a little less in breadth; while its arms measure 0·07 inch in breadth at the widest part, a little above the top of the body, where about eight arm pieces may be counted in a length of the same extent.

This species will be readily distinguished from all of the described forms of the genus, resembling it in other respects, by having only ten simple arms, and by the large number and small size of its interradial pieces. In the latter character it resembles *G. Nealli*, of Hall, from which, however, it differs materially in almost every other respect, but more particularly in having only ten instead of twenty arms, which are also stouter. Its interradial and axillary spaces likewise differ materially in not being distinctly excavated, and in having each of the little pieces by which they are filled provided with a little projecting point.

The specific name is given in honor of Dr. O. P. Baer, of Richmond, Indiana, to whom I am indebted for the use of the specimens from which the description has been prepared.

Locality and position.—Upper part of the Cincinnati group of the Lower Silurian, at Richmond, Indiana.

NOTE ON THE GENUS LICHENOCRINUS.

Since the publication of the note on the genus *Lichenocrinus*, issued in the January number of this Journal, Mr. Dyer, at my request, sent on a specimen of this type which I had seen in his collection last summer, that shows the disc separated from the matrix in such a manner as to expose both the upper and the lower sides. In this one alone, of all the numerous specimens that have been found, there is on the flat or under side, a small central opening, that I have supposed to be due to some accident, and radiating from this, are seen numerous regular fine raised lines, with little linear furrows of the same breadth between them. In looking at this specimen alone, without any knowledge of others, one could scarcely entertain a doubt that this opening, situated so exactly at the center of radiation, must be the mouth, and the minute radiating furrows the ambulacral canals. A careful examination under a magnifier, however, shows that the little raised lines between the furrows *bifurcate* regularly several times, so that the little furrows, in part, do not reach the central opening, but end abruptly at the points of bifurcation. Again, as has already been several times stated, specimens that grew attached to the surface of some smooth body, have been separated from the same, so as to show the under surface of the basal layer, or platform, as it may be called, of the disc; and here we find it without any opening whatever, or traces of radiating striæ, on the under surface. But when moistened, and examined under a magnifier, these regular radiating striæ can be seen through its

thin translucent substance within. In numerous other instances where these basal platforms can be seen still firmly attached to their original station, with the plates of the upper side and the internal lamellæ wholly, or in part removed, the inner, or upper side of this platform can be clearly seen to be without a trace of a central or other opening, and marked by numerous slender radiating lines corresponding to the lamellæ of the interior. A portion of these striæ can be distinctly traced to the central point, where, instead of an opening, there is often even a minute elevation. It is also worthy of note, that here, on the inner surfaces of these basal layers, the little raised radiating lines, like the lamellæ within the disc, do not increase by *bifurcation*, but by the *intexcalition* of shorter ones between the longer; so that if we were to place the specimen mentioned above, showing the central opening and striæ of its under side, on one of these basal platforms, the elevated striæ of its under side would conform to the little furrows of the platform in such a manner that these little furrows would all be closed.

If it were not for this fact, and the absence of any indications, so far as yet known, of any minute openings around the base of the periphery of the disc, at their connection with the bodies upon which they grew, I should be half inclined to suspect that there might be a double basal layer sometimes capable of accidental separation, with a central opening to an internal mouth through the upper one, and numerous minute ambulacral canals passing to this opening *between the two layers.* The bifurcating striæ on the flat under side of this specimen showing the opening, can hardly be, as I at one time supposed, the edges of the internal lamellæ exposed by weathering, because their bifurcating character would seem to show that they do not coincide with the lamellæ within, but with the *interstices between them*; while there are no open slits between these striæ, as we would expect if they were the edges of lamellæ, but mere furrows.

As I have already remarked, if these discs are really *bodies*, they must belong to a form constituting the type of a strongly marked family of the *Cystoidea*, if not typical of a more important section.

ART. XXXIII.—*Note on Recurrent Vision;* by Prof. C. A. YOUNG, of Dartmouth College.

IN the course of some experiments with a new double plate Holtz machine, belonging to the college, I have come upon a very curious phenomenon, which I do not remember ever to have

seen noticed. The machine gives easily intense Leyden jar sparks from seven to nine inches in length, and of most dazzling brilliance. When, in a darkened room, the eye is screened from the direct light of the spark, the illumination produced is sufficient to render everything in the apartment perfectly visible; and what is remarkable, every conspicuous object is seen *twice* at least, with an interval of a trifle less than one-quarter of a second—the first time vividly, the second time faintly; often it is seen a third, and sometimes, but only with great difficulty, even a fourth time. The appearance is precisely as if the object had been suddenly illuminated by a light at first bright, but rapidly fading to extinction, and as if, while the illumination lasted, the observer were winking as fast as possible.

I see it best by setting up in front of the machine, at a distance of eight or ten feet, a white screen having upon it a black cross, with arms about three feet long and one foot wide, made of strips of cambric. That the phenomenon is really subjective, and not due to a succession of sparks, is easily shown by swinging the screen from side to side. The black cross, at all the periods of visibility, occupies the same place, and is apparently stationary. The same is true of a stroboscopic disc in rapid revolution: it is seen several times by each spark, but each time in the same position. There is no apparent multiplication of a moving object of any sort.

The interval between the successive instants of visibility was measured roughly as follows: A tuning fork, making $92\frac{1}{2}$ vibrations per second, was adjusted, so as to record its motion upon the smoked surface of a revolving cylinder, and an electro-magnet was so arranged as to record any motion of its armature upon the trace of the fork: a key connected with this magnet was in the hands of the observer. An assistant turned the machine slowly, so as to produce a spark once in two or three seconds, while the observer manipulated the key.

In my own case the mean of a dozen experiments gave $0^s{\cdot}22$ as the interval between the first and second seeing of the cross upon the screen; separate results varying from $0^s{\cdot}17$ to $0^s{\cdot}30$. Another observer found $0^s{\cdot}24$ as the result of a similar series.

Whatever the true explanation may turn out to be, the phenomenon at least suggests the idea of a *reflection of the nervous impulse* at the nerve extremities,—as if the intense impression upon the retina, after being the first time propagated to the brain, were there reflected, returned to the retina, and from the retina traveling again to the brain renewed the sensation. I have ventured to call the phenomenon "Recurrent vision."

It may be seen, with some difficulty, by the help of an induction coil and Leyden jar; or even by simply charging a Leyden jar with an old fashioned electrical machine, and discharging it in a darkened room. The spark must be, at least, an inch in length.

Hanover, Feb. 9, 1872.

ART. XXXIV.—*Observations on the Total Eclipse of the Sun of 1869*; by CLEVELAND ABBE, Director of the Cincinnati Observatory, Assistant in the Office of the Chief Signal Officer, Washington.

AMONG the parties organized to observe the total eclipse of 1869, Aug. 7th, that sent from the Cincinnati Observatory was probably favored above all others in the advantages of having a comparatively elevated station and exquisite atmosphere. The publication of the work done by this party has been delayed by the fact that, for a year subsequent to the eclipse, I was wholly absorbed in the labor attending the maintenance of the "Weather Bulletin of the Cincinnati Observatory," and my subsequent occupations in the present office have entirely prevented me thus far from even attempting the reduction of our observations; the original note books are at present packed away with the library of the observatory, awaiting the removal and rebuilding of that institution.

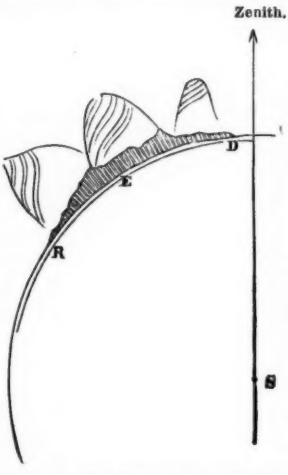
My own attention was expressly given to the structure of the corona and coronal streamers, for which I used the full aperture of an exquisite six-inch objective (one that had received a prize at the Paris Exposition Universelle), and which was loaned to the eclipse expedition by Mr. T. G. Taylor of Philadelphia. A short notice of the principal features noted by myself was sent at once to the editor of the Astronomische Nachrichten, but has not yet been published, and I therefore take the liberty of restating, through your Journal, the simple phenomena that I then saw.

Our station was at Sioux Falls City (formerly Ft. Dakotah), in the southeastern corner of Dakotah Territory, latitude 44°, longitude 97°, elevation about 1,500 feet above sea level, in the midst of an extended plateau.

Rain and cloud had continued up to a few hours previous to the critical moment, but the atmosphere during the eclipse was of surpassing steadiness and clearness. The altitude of the sun at the time of totality was about 40°, the local time 3½ P. M., the duration of totality four minutes. No sooner had totality begun than after sketching in most of the prominences as points of reference, I viewed the corona without darkening glasses, and with a magnifying power of probably 120 diameters.

The whole interval of totality was unfortunately not at my disposal, owing partly to the very rough and faulty stand supporting the telescope (everything had to be transported an hundred miles by mules into a wilderness), and partly to an interruption by one of the members of the party; but there seemed to me to be no doubt of the facts as recorded, nor was I conscious of the least undue emotion that might have interfered with my reliability as a witness, although it was the first total eclipse I have ever had the pleasure of observing.

As seen through my inverting telescope, the structure of the largest protuberance on the right hand lower limb was well made out. The neighborhood of the sun was examined to a distance of its own diameter (a radius of possibly one degree from the sun's center), but no trace of the coronal rays as they were seen by others of my party. The evidence as to the existence, shape and positions of these streamers as given by my six assistants, was conclusive as to their actual appearance, with the usual variations as to details. That they were not detected by the six-inch glass was probably due to their diffused light and the small field of view. On the apparent upper and right hand limb of the sun, the six-inch glass showed the long series of red prominences depicted in the photographs published by the Naval Observatory; above the greater portion of the arc of the sun's limb thus covered, and extending somewhat further to the right, appeared to rise up three, and possibly more, conical masses of pearly light. These were distinctly contrasted against the light diffused as the background of the field of view, and there was every evidence that they had an identical structure and cause. The outline of each of the pearly mountains was that of a rounded cone, as shown in the drawing, exactly resembling the kilns used in some branches of pottery, and other manufactures. The apices of the cones were blunted or truncated, and not well defined; the outlines of the sides of the cones were quite sharp down to within a few minutes of the sun's limb, when all three appeared to begin to lose their distinctive characteristics.



The height of the apices above the limb varied between one half and two thirds of the solar radius: the diameters of the

bases of the cones was probably included between seven and three minutes. Each apex was of a slightly dusky shade compared with the body of the cone.

The most interesting feature was an unmistakable striation upon the surface of each cone, the striæ apparently twisting spirally around up to the apex opposite to the movement of the hands of a watch as represented on the accompanying drawing.

I noticed no colorations of these striæ other than their darker hue. The details of this striking and new phenomenon interested me so much that I naturally enough lost the observation of the third contact. The pearly cones were on that limb of the sun from which the moon was moving, and the details were every moment becoming more distinct, when the growing height of the bank of red protuberances was followed by the too speedy apparition of the glowing sun beneath.

Chagrin at the loss or imperfect observation of the third contact, caused me to forget to note whether the three cones continued in view for any number of seconds thereafter. From the time of first recognizing the pearly cones until their disappearance probably thirty seconds elapsed (I am writing without my note book or other aid to memory), and I did not note any change in the appearance of the striæ. The middle one of the cones caught my eye more particularly, and the impression was that the other two, especially that on the right, was some distance behind it, or possibly obscured by a cloud of haze in the solar atmosphere.

At the time it seemed to me that I saw in the central cone a column of smoke and hot gas ascending high above the area of red flame, then visible on the surface of the sun, and that the other two cones corresponded to other areas of red flame far behind. The difference in character and position between these cones and the coronal streamers, as observed by the others with the naked eye, and with opera glasses, seemed to argue that the latter were very probably individual and subjective phenomena or that they originated in the earth's atmosphere, while the pearly cones existed in the solar atmosphere and constituted a true solar corona.

My long delay in making this communication to the scientific world will be excused, I trust, in view of the imperative demands made upon my time during the two years that have elapsed since the eclipse of 1869. I shall be deeply interested to learn whether the phenomena seen by myself may not be repeated on some other occasion and be studied by more experienced observers.

I may add that I had hastily provided myself with a Nicol's prism, in hopes to make at least some trial of the nature of the

coronal light; but the rude apparatus did not work satisfactorily, and I confined myself to details of structure; indeed in my earnest gaze upon the novel phenomena I quite forgot the polarizing apparatus.

Washington, D. C., Feb. 6th, 1872.

ART. XXXV.—*Acoustical experiments, showing that the translation of a vibrating body causes it to give a wave-length differing from that produced by the same vibrating body when stationary;* by ALFRED M. MAYER, Ph. D., Professor of Physics in the Stevens Institute of Technology, Hoboken, N. J.

THE APPARATUS.

FOUR tuning-forks mounted on resonant cases and giving the note UT^3, =256 complete vibrations per second, were obtained. I will designate them as Nos. 1, 2, 3, and 4.

Nos. 1 and 2 were brought into perfect unison by a process to be described.

No. 1 was placed before a lantern, and just touching one of its prongs was a small ball (5 or 6^{mm} diam.) of good cork, suspended by a silk fiber. The images of the fork and of the cork-ball were projected on a screen.

No. 3 had one prong weighted with wax, so that it gave two beats a second with No. 1 or 2.

No. 4 had the ends of its prongs filed off, until it also gave two beats per second with 1 or 2; thus No. 4 gave two vibrations a second more than No. 1, while fork No. 3 gave two vibrations a second less than No. 1.

THE EXPERIMENTS.

In the experiments, one to seven inclusive, fork No. 1 remains before the lantern, with the suspended cork-ball just touching one of its prongs.

Exp. 1. Fork No. 2, screwed on its case, was held in the hand, at a distance of 30 to 60 feet from No. 1, and sounded; the ball was projected from the prong of fork 1, which vibrated in unison with 2.

Exp. 2. I stationed myself 30 feet distant from fork No. 1, and fork No. 2 was screwed off its case and vibrated in one hand, while the case was held in the other. I now walked rapidly toward fork 1, and after I was in regular motion, I placed the fork on its case, and just before I ceased walking I took it off; although, when I did so, I was only about a foot from fork 1, yet the cork-ball remained at rest against its prong.

Exp. 3. Again I walked toward 1 as in Exp. 2, *but* I did not

remove the fork from its case after it was placed on it. The ball remained at rest until the moment I suddenly stopped walking; at that instant, the ball flew from the fork, while an assistant, whose ear was close to the case of fork 1, while his eye was directed to the screen, found that at the instant I stopped walking, the fork 1 sounded, while the ball jumped from its prong.

Exps. 4 and 5. These experiments were exactly like Exps. 2 and 3, except that I walked away from fork 1 instead of approaching it. The results were the same as in Exps. 2 and 3.

Exp. 6. Fork No. 3, giving 254 vibrations per second, was sounded as in Exp. 1. It had no effect in moving the ball. I now screwed the fork off its case, and standing about 30 feet from fork 1, with my arm, I swung the case toward fork 1, and while it was approaching it, I placed fork No. 3 on the case; the proper velocity (from eight to nine feet per second) having been obtained, the ball was suddenly projected from fork 1. On greatly increasing or decreasing the above velocity of the moving case, the vibrations of fork 3 produced no effect on fork 1.

Exp. 7. Fork No. 4, which gives two vibrations per second more than No. 1, was substituted in Exp. 6, *but* was placed on its swinging case, when this was *receding* from fork 1. The effect of this motion and of varying velocities was the same as in Exp. 6.

Exp. 8. I placed fork 3 before the lantern, and swung fork 1 as in Exp. 7. The effects were the same as described in Exp. 7.

Exp. 9. I now placed fork 4 before the lantern, and moved fork 1 as in Exp. 6. The effect on the ball was the same as in Exp. 6.

By these simple experiments I have shown the change of wave-length produced by the translation of the vibrating body, and have given an experimental proof of the important theorem which Doppler established in 1841. By analogy they clearly unfold that exquisite modern method of determining the motions of a heavenly body by variations in the refrangibility of the rays which it emits—motions often impossible even to detect by any other means. I, therefore, deem it proper that I should proceed to state the delicate conditions on which depend the perfection of experiment, which so satisfactorily elucidate the nature of those grand and refined problems offered to spectral observation.

It is, first of all, essential that forks 1 and 2 should really be in unison. Two forks, sounded together, may give no perceptible beats, for they may constrain each other into a common forced oscillation, and thus both will give the same number of vibrations, yet may be removed from equality when separately vibrated. The process I have adopted is as follows:

Three forks are taken which are supposed to give the same number of vibrations in a given time. They are supported on india rubber tubing, and are thus insulated. One of the forks is now loaded so that it gives two or three beats in a second, with one of the other two that are to be brought into exact unison. The interval of time occupied by 20 or 30 of these beats, is accurately determined by means of a chronograph (one of Casella's registering stop-watches does very well). The interval occupied by the same number of beats given with the second fork, is now ascertained, and if it differs from that given by the first, the quicker vibrating fork is made to give the same number of beats as the slower by loading it with wax. When the forks have thus been carefully adjusted, I have had no difficulty in projecting the ball, in Exp. 1, at a distance of 60 feet, and I believe that it could have been accomplished at a distance of 100 feet. The ball of cork should be *spherical*, so that it will always just touch the fork, no matter how much it may rotate around its suspending thread; which latter should consist of only one or two fibers of unspun silk. The cork is rendered as smooth as possible and is then *varnished:* this is important, for the varnish gives a firm coating to the ball, without sensibly increasing its weight, and is especially useful in covering the minute asperities or elastic projections on its surface, which otherwise would act as "buffers" to the impacts of the fork and deaden its projectile effects.

The above stated conditions having been obtained, no physicist will have any difficulty in repeating these experiments.

A machine has been devised by which a uniform motion of translation can be given to the forks, and with this I propose making a quantitative investigation of the phenomena, using an apparatus essentially the same in its action as the one here described.

We may substitute for the suspended cork-ball a light plane mirror, held between two stretched vertical fibers, while one of its edges touches the fork. The motions of a beam of light reflected from the mirror to a screen, indicate most beautifully the vibrations of the fork. This ingenious and most delicate device for detecting vibrations, is due to Prof. O. N. Rood, of Columbia College, N. Y., who first used it in a public lecture, delivered in New York, on the 28th of last December. We have, however, in our special work, found the image of the projected ball more convenient, and sufficiently delicate, for our experiments.

Quantitative relations in the experiments and analogical facts in the phenomena of light.

The UT_2, No. 1 fork, makes 256 complete vibrations in one second, while fork No. 3 makes 254, giving for the respective

wave-lengths of these vibrations 4·367 and 4·401 feet, which we will designate in order as λ and λ' We will take 1118 feet per second as the velocity of sound at 60° Fahr.

Now 256 vibrations in 1118 feet make $\lambda = 4{\cdot}367$ feet.
and 254 " " $1118 - 2\lambda$ $(= 1109{\cdot}266)$ give $\lambda = 4{\cdot}367$ feet.

As the velocity of propagation of the vibrations and λ are the same in both cases, it follows that $\left(n = \frac{V}{\lambda}\right)$, the number of vibrations in a second, reaching a distant point, is the same, and, therefore, 256 vibrations from a body at rest will produce the same effect on a distant surface, as 254 vibrations emanating from a body which moves toward that surface, with a velocity of 2λ, or of 8·734 feet per second; and this is the velocity we gave the fork in Exps. 6 to 9.

We will now examine the analogical phenomena in the case of light. Let fork No. 1, giving 256 vibrations a second, stand for 595 millions of millions vibrations a second, which we will take as the number of vibrations made by the ray D_1 of the spectrum. Then fork No. 3 will represent 590 millions of millions vibrations per second; which give a wave-length ·0000042 millimeter longer than that of D_1; and nearly corresponds with an iron line situate ·42 div. below D_1 on Angström's chart. We saw that fork No. 3, giving 254 vibrations a second, had to move toward the ear with a velocity of 8·734 feet, to give the note produced by 256 vibrations per second, emanating from a fixed point; so a star sending forth the ray which vibrates 590 millions of millions a second, will have to move toward the eye with a velocity of 28470 miles per second to give the color produced when ray D_1 emanates from a stationary flame.

February 8th, 1872.

ART. XXXVI.—*Note on a Question of Priority;* by E. BILLINGS, Paleontologist of the Geological Survey of Canada.

IN the Canadian Naturalist, published on the 29th of Dec., 1871, I proposed two new genera of Brachiopoda, *Monomerella* and *Obolellina*, both belonging to that group which includes *Trimerella*, so abundant in the Guelph limestone of Canada. *Obolellina* is intended to include at least one of the forms described by me under the name of *Obolus Canadensis*, in the report of our survey published in 1858.* A second species is

* The form here alluded to is fig. 20, p. 189, of the report. It shows the interior of a dorsal valve imperfectly. This may not be *O. Canadensis*; but at present I think it is. Should it be otherwise, it does not affect the question. The fossil will only require another specific name.

O. Galtensis, an imperfect cast of a dorsal valve of which was figured in my Pal. Foss., p. 108, in 1862. Neither of these species, so far as I know, has ever been found in New York.

About three weeks after my paper was published, I received information from Thos. Davidson, Esq., of Brighton, England, the eminent Brachiopodist, that Prof. Hall had descibed *Obolellina*, under the name of *Rhynobolus*, in a pamphlet of five pages, purporting to have been published in March, 1871. As no copy of this paper had been received at our survey, I immediately caused extensive enquiries to be made in the United States, among those who would have been the first to have procured it, had it been regularly published. I have heard from a number of geologists, professors in colleges, and scientific institutions, including five geological surveys, besides that of Canada. With a single exception, no one had received the pamphlet. Several expressed the opinion that the copy sent to Mr. Davidson was the only one that had been issued. One gentleman, on the 12th Feb., sent me a copy, but did not state when he received it, probably because he did not like to meddle with the matter. I cannot find that it is noticed in any of the scientific journals of the United States or Europe. We know that in America, where geology and paleontology, are so actively and ably cultivated, any book or pamphlet relating to these two branches very speedily finds its way to those interested. It is almost impossible for this pamphlet to have been regularly published, in the United States, for the long period of ten months, and yet to have remained totally unknown to the leading geologists of the country. It seems quite certain that it was not published, but only printed, and perhaps two or three copies privately distributed.

As I understand the laws laid down by both the British and the American Associations, a species or a genus must be published in a book, or in a journal circulating among scientific men. The book or the journal must be obtainable by the public, by purchase. If an author having a book in the press, should make an abstract of four or five pages, and give away a few copies to his friends, it would not be publication, but only private distribution. This cannot take priority over fair and open publication in a scientific journal. Yet this is exactly the case with Prof. Hall's pamphlet. The laws in question are good and wise rules, intended to prevent disputes among naturalists, and also to afford the public a means of deciding questions of priority, without resorting to the testimony of either of the parties disputing. He who claims that printing is sufficient desires to make himself judge and witness in his own case. He and his printer can evade the law whenever they think proper. If printing is sufficient, then let

us strike out the word "priority" from the pages of science. A rule that can be evaded by every one is a dead letter.

In addition to the above, I beg to give a short statement of facts, to prove that I am not to blame for the unfortunate collision that has occurred. During the winter of 1871 there was a correspondence in progress, between Mr. Davidson, Mr. Dall, myself and others, on the subject of the genus *Trimerella*. In February and March, Prof. Hall, on two occasions, applied to Mr. Selwyn for the loan of specimens of *Trimerella*, *Kutorgina*, and *O. Canadensis*. He stated that he wanted them in order to decide a question relating to his species, *O. Conradi*. He gave no notice of his intention to found a new genus on any Canadian specimens. I consented to the loan of all but *O. Canadensis*. I was then studying this species in connection with the *Trimerella* question. I afterward arrived at the conclusion, that at least one of the forms figured under that name might constitute a new sub-genus along with *O. Galtensis*. In a letter to Mr. Selwyn, dated April 10th, 1871, in allusion to my declining to lend *O. Canadensis*, Prof. Hall says: "I certainly have no wish to take advantage of Mr. Billings in any way, and desired only to make my position as secure as practicable." How this assertion can be sustained, by what came to light nine months afterward, I leave the public to judge. In the same letter he intimated that he had made a little abstract of his investigations,—that he had saved a few copies from the fire that had occurred at Albany about that time, and that he would send Mr. Selwyn one. He never sent it, however, as he afterward admitted.

On the 6th Dec. I received a letter from Mr. Davidson, in which he mentions Prof. Hall's pamphlet, but makes no allusion to *Rhynobolus*. My paper was at this time in print, and I sent Mr. Davidson a proof of it on, or about, the 8th of Dec., and at the same time some specimens. I heard no more from Mr. Davidson until the 17th of Jan., 1872. On that day I received several letters from him, some of which had been delayed at sea. From these letters I first learned that Prof. Hall had proposed the name *Rhynobolus* for my genus *Obolellina*. I then made the inquiries above mentioned, and having satisfied myself that the paper had not been regularly published, asked Mr. Selwyn to apply to Prof. Hall for a copy. He wrote on the 30th Jan., and the pamphlet arrived here on the 9th Feb. There is a plate stitched to it, with a manuscript description of the figures. The genus is proposed on a Canadian specimen from Galt, the original *Trimerella* locality. Prof. Hall says he procured the specimen there, "many years since." It thus appears that at the time he borrowed our specimens, he was engaged upon one from the same locality, and wanted ours for

comparison. Mr. Selwyn, when he lent the specimens, gave him notice of the correspondence then going on between Mr. Davidson, Mr. Dall and myself, and also that I was at work upon *O. Canadensis.* Prof. Hall should have notified Mr. Selwyn that he was engaged on the Canadian specimen, or he should have published his genus. He did neither, and it remains for the public to decide whether he was right or not.

It appears from Mr. Davidson's letters, that *Rhynobolus* was to have been brought out in England, in a paper which he (Mr. Davidson) and Prof. King had in preparation on the *Trimerella* group. I knew nothing of this. We can now see why it was kept so quiet in America. Fortunately, Mr. Davidson delayed his paper for a box of specimens I had promised him, and these I could not well spare until my own paper was finished. Mr. Davidson appears to be under the impression that Prof. Hall's pamphlet has been regularly published.

What is stated above, can be authenticated by a number of letters written by Prof. Hall, Mr. Davidson, and some of the best scientific men in the United States.

Montreal, 26th Feb., 1872.

Art. XXXVII.—*The Aurora of February 4th, 1872;* by Prof. Alex. C. Twining.

Excepting the auroral cloud-band of October 24th–25th, 1870—an account of which was given by the writer of this article in volume i, No. 2, of this series—no aurora ever before observed in the United States has exhibited, so far as our knowledge extends, any feature essentially identical with the crimson band or belt in the south seen here throughout Sunday evening, the 4th of February last. It was composed of large illuminated clouds or banks of red light, aggregated in the form of a zone, which began far down in the east and passed south of the zenith far on to the west. Its visible parts shifted place a few degrees, from time to time, but without altering very much the general position of the zone. No "aurora's bow" ever possessed half, and rarely more than one-third its breadth, or had either the like consistence or constitution, or the like color and time of continuance, or the like invariableness of position. Indeed, it is a fact which the writer can avouch from his own observations, that—excepting the extreme western parts, which he did not observe early in the evening—the zone maintained essentially the same extent and situation, relative to the stars, at a quarter past ten o'clock in the evening which it had here at New Haven at a quarter before seven. The same fact, it

will be noticed farther on, was observed for a much longer time—four hours and a half—by intelligent and trustworthy witnesses, at Brunswick, Maine, and at Hudson, New York,—respectively 170 miles N.N.E., and 80 miles N.W. from New Haven. This anomaly, however, is no more than was noticed for a much longer period in 1870—essentially for not less than a full twenty-four hours, as will be seen by referring to the writer's account of it in the article above quoted. Besides all this, it is curious—whatever want of significance there may be in the coincidence—that this new manifestation, after a year and four months, almost, from its predecessor, was posited in the celestial vault much like the zone of 1870, only advanced upon the ecliptic over one sign, but keeping its inclination to that circle nearly the same: for, in 1870, the middle line, as seen here, was a great circle crossing in 18° of Pisces, and inclined 40°, while the same line, in this last instance, crossed at about 24° of Aries, and was inclined 37°. The zone, certainly, was *not* cosmical; for it embraced auroral streamers, both red and white, although, in this instance, very short. It was also part of a display which was showing itself simultaneously in the opposite quarter, as the ordinary "Northern Lights." Besides these things, it was affected by parallax, as will be seen abundantly from the concurring testimony of observers at distant places, when compared together; and it also showed the usual spectrum lines of the aurora. The fixed position among the stars, although extremely surprising, may be explained, perhaps, by a reference to facts which are known respecting the frequent western movement (although sometimes eastern) of auroral clouds, arches and streamers; but the coincidence of inclinations to the ecliptic cannot be surmised to be more than fortuitous, so long as it does not appear from known facts that the earth, by motion in its orbit, crosses lines of magnetic force which can exercise an exciting and determining influence upon its electric currents.

Another respect in which these zones of 1870 and of 1872 are distinguished is their great height above the earth's surface. In both instances the data for computing this element are but rude, yet they are unmistakable in their reality and general result. The former height (339 miles) is less to be relied upon as a near approximation to the truth than this last (352¼ miles), because, for this last, the observations are more ample and more definite. What the writer himself saw, both north and south, may be described briefly, as follows:—At 7^h P. M. there were three bands, apparently parallel, from east to west, having their general aspects and their general situation the same as observed accurately half an hour later. At $7^h\ 30^m$ the most northern appearance was a white and moderately brilliant arch that crowned

a dark space or disc beneath it. Its breadth was 16°, and its upper boundary lay at or closely contiguous to Regulus and to Delta Ursa Maj. Thus it enveloped the handle of the "Dipper," and it extended down to the horizon both on the east and on the west. Between this and the zenith there was a rosy band, obviously parallel to the last described, rising from the eastern horizon, and passing up between and grazing Gamma Gemin., on the north and Betelgeux on the south, but becoming diffused and indefinite soon after passing the meridian. South of this a streak, partly white and partly azure, adjoined the last named, separating it from the cloud-band of red lights in the S.E., the S., and the S.W. This last began a few degrees below Canis Major, and just enveloped the bright stars of that constellation. Its north margin passed 1° south of Beta Orionis, and its south margin nearly reached Epsilon Leporis. Farther west the north margin reached 1° or more above Alpha Ceti,—from which star the band passed far westward, irregular and less brilliant, but in the same circle and of about the same breadth. About 8 o'clock it all became temporarily faint. At $10^h\ 15^m$ both margins remained, in general situation as before, and also the eastern extremity nearly or exactly, and apparently also the western extremity, which faded out at about the distance of Andromeda. Thus the arch was about 123° in extent and 11° in breadth, conforming substantially in these respects with the similar arch of 1870. At the time of last observation the band was equally brilliant as at first, but clouds rapidly formed and covered it from sight.

The well known and accurate observer, B. V. Marsh, Esq., of Philadelphia, among other observations, has obligingly communicated the following, made by himself at Haverford, ten miles west of that city:—

"Feb. 4th, $7^h\ 20^m$ P. M. Brilliant crimson light in S.E., principally in Canis Maj. and Orion; Sirius was near the center of an exceedingly fiery patch, which extended some 5° or 6° below and eastward, and in the west joined another but little less brilliant, enveloping the brightest part of Orion.

$7^h\ 23^m$–$7^h\ 30^m$. Several crimson streamers in Canis Maj. and Orion, with one crimson and white from the west, and one faint white from the north, form a partial corona, which dissolved before $7^h\ 35^m$.

$7^h\ 55^m$. Yellowish white glow [continues] over N. and N. E., especially the latter, involving the whole handle of the "Dipper." Sirius still nearly central in large patch of crimson, extending 5° to 10° below, and about the same distance toward the E., connecting in S.W. with another at about the same level under Orion. Crimson less splendid than at $7^h\ 20^m$.

$8^h\ 40^m$. Canis Maj. and Orion still enveloped in crimson light, higher than at $7^h\ 55^m$. Sirius still in brightest part.

10^h 20^m. Crimson in S.E., S., and S.W.—especially in Canis Maj. and *lower* half of Orion,—extending 10° to 20° E. of Sirius, which was still in brightest part. Upper margin perhaps 10° N. of Sirius—lower as much S. of it."

Respecting this same aurora, Prof. C. G. Rockwood of Bowdoin College, obligingly communicates, among other things, the following:—

"On the evening of Feb. 4th, at Hudson, I saw it first a little before 7 P. M., being a brilliant patch of red light in the S.E. It was of irregular shape, the brighest part being about over the three stars Alpha, Beta and Gamma Leporis—say in A.R. 82° Dec. −20°, and extending with a variable breadth, like a bank of colors, toward and over the triangle formed by Delta, Epsilon and Eta Canis Maj.—say across a point in A. R. 105°, Dec. −28°. At 7 P. M. there were visible two or three faint white streamers stretching far up toward the zenith and resting upon the red as a base. The red mass continued visible, though varying in intervals, until after 11 o'clock. At 11^h 30^m P. M. it had faded away.

I had given up all hope of any parallax, from the remarkable fact that the red patch *retained the same position among the stars* all the evening, moving with them from west to east. Prof. Brackett, who observed the phenomenon *here* [Bowdoin Coll., lat. 43° 54′ long. 69° 57′], noticed the same thing."

In addition to the foregoing, Assistant Arthur Searle of Harvard Coll. Observatory, has obligingly communicated the following:

"The red southern arch of Feb. 4 was very ill defined. I have the following notes: 'At 6^h 25^m P. M. reddish light diffused from below Orion to square of Pegasus' [90° extent]; at 7^h 35^m band in the south nearly white, covering most of Canis Major. Mr. Trouvelot, observing here, made the following notes: 'At 8^h 15^m P. M., arch dark purple, about 8° or 10° wide where it was broadest; its northern edge nearly reaching the nebula of Orion, very vaporous and ill defined.' At 8^h 40^m it just reached the Orion nebula. At 10^h 50^m lower than before, and almost exactly resembling in form the pale arch in the north, as if it were a reflection of it."

The problem relative to actual height in the early evening is somewhat *refractory*. The displacement of the zone, measured in a direction across itself, appears to have been 8° between the station of Hudson and that of Haverford, $179\frac{1}{4}$ miles S., $28\frac{1}{2}$° W. from it,—and $5\frac{1}{3}$° between New Haven and the same, being $158\frac{3}{4}$ miles, S. 54° W. These give, consistently, 10° and $7\frac{1}{3}$° of parallax in the *azimuthal* planes. An extraordinary height would seem to be indicated by the foregoing, but specific results cannot be attempted at this point.

This aurora was observed with the spectroscope by Professor

Brackett of Bowdoin College. He obtained *two* lines in the white aurora, one of which was wanting in the red. Prof. Geo. F. Barker, of Yale University, has obligingly furnished the following observations of his own:

"The aurora was observed with the spectroscope about 8 P. M. Three bands were then plainly visible, two of them quite sharply defined. The least refrangible of these was the well-known red line, first observed by Zöllner. On measurement, it gave a wave-length of 623 millionths of a millimeter. The second in order was the bright line of wave-length 557, as given by Angström. The third was a nebulous band slightly more refrangible. Mr. C. S. Hastings informs me that at seven o'clock he was able to detect five lines in the auroral spectrum. Beside the three above mentioned, there were two others more refrangible. These were, however, too feeble for measurement.

The white auroral cloud which lay for a time beneath the western end of the fiery red tract, and the white streamers which shot up from the north, afforded a similar spectrum, but without the red line."

The illustrated British journal "Nature" is our authority for the statement that this display was very brilliant over all England and Ireland; also in France, Turkey and Egypt. A telegram from Alexandria is therein quoted, as saying that a large space of the sky was seen illuminated at that place for five hours. Varying descriptions by different observers abound in the same journal, and are very glowing; but nothing new appears beyond the splendor, variety and duration, unparalleled for those parts. In several instances the green and red lines of the spectrum were recognized, and in some instances blue also. Red is mentioned as the prevailing color of the auroral clouds and sometimes of the streamers; and the illumination at times was so great that large print could be read by it. The dipping needle also was disturbed, in advance of the visible phenomena, and changed all the way from 56° to 45°. The splendor was visible in the bright twilight of sunset, and continued bright from 5 o'clock P. M., until about 10 o'clock.

The same phenomena were witnessed at Rome in Italy, as we learn from the "Bulletino Meteorologico." At $5^h\ 47^m$ P. M. they were visible in the twilight, first in the N. and N.E., but soon after in the N.N.W., and then in an arch of light from E. to N. 60° W.; and a rosy light also, beginning in the N.W., spread over the entire heavens. The yellow light gave, in the spectroscope, one greenish-yellow line, and the red columns gave a red line. At 7 o'clock festoons of light passed the zenith, and appeared at the Pleiades and in Orion. At $7^h\ 7^m$ the corona first formed by rays converging to Aldebaran; and, at $7\frac{1}{2}^h$, a luminous cloud-zone, normal to the meridian, moved

from north to south, but became merged in a vivid purple radiance diffused over the whole sky, and streaked with yellow. At $7^h\ 55^m$ the point of convergence was at Alpha Orionis. The whole reminded one of the vast cupola of St. Peters. The apex was and continued at the magnetic pole. About 9 o'clock the illumination became languid, and only remained as a homogeneous rosy radiance from N.E. to N.W. At 10 o'clock this revived somewhat, but disappeared entirely at half-past three in the morning. There were great magnetic disturbances, occasioned by strong electric currents along the wires. Telegraphic communications from Modica and Palermo gave information that the display was seen in Sicily.

The Cologne Gazette of Feb. 9th contains a complete and vivid description of the appearances in that part of Germany. Beginning at $5\frac{1}{2}$ P. M. in the east, in appearance like a reflection of the western twilight, it was attended, after some minutes, by a reddish brightness in the west, and banks of *green* light in the southeast which soon faded, excepting a bright border to the south. Toward 6 o'clock streamers arising disclosed the unmistakable auroral character. The masses became more richly and sharply grouped, and at $6^h\ 25^m$ a corona was formed. Nothing was then in the N. for 20° of altitude; but, in the S.S.E., a dark gray bank of mist, never before seen in the south, culminated in the south magnetic meridian at 30° altitude. Canis Maj. shined through it, and a green shimmering border formed its upper boundary. Above it there was white light passing into bright red crossed with streamers. In the S.E., under the Pleiades, 65° above the horizon, rested its center—in form as a dark circle six to ten moons in diameter, and rays from it on every side,—short to the S., moderately long to the N., long and rich to the east and west. This corona stood five minutes, then was gone; but after five minutes it produced itself with yet greater splendor. Again it formed complete at $6^h\ 37^m$—beautiful to the east, while to the west two mighty red streamers wonderfully enclosed a ruby red space, like a sunken ground, which streamed on nearly in a true line almost to the western horizon. This faded in a few minutes. Just about 7 o'clock a third corona formed, with pale and delicately white rays, in a sky whose lower parts were occupied by irregular luminous mists and streamers. When these were gone they left behind, even so late as 10 o'clock, a weakly shining phosphorescent mist, which showed the bright stars through.

The display was an utter novelty in the region, in these particulars: 1st, the formation and aspects in the east and west at the outset; 2d, in the three coronas,—of which sort of development never one had been witnessed before; 3d, in the dark disc in the south, instead of the north, as usual. Unfortunately

science is helpless with reference to these phenomena, because, in these parts (!) "people are more disposed to wonder at the auroras than to observe them." The telegraph reports these appearances in Silesia, Posen, Western Prussia, and in Paris, with much disturbance of the wires,—also at Alexandria, over all the sky, for five hours,—and at Constantinople at 10¼ o'clock, at least, and till 1½ o'clock in the morning. At Cardiff the same was spoken of, as in the zenith, with an elliptical corona of silvery blue streamers toward the north, the east, and the west.

At Cologne Dr. Schellen observed the spectrum for two hours, with three differently constructed instruments. It agreed essentially throughout with that of October, 1870, by Prof. Zöllner, described in Schellen's "Spectrale-Analyse," 2d ed., p. 597. The intense green, 1474 K, was seen in every direction,—the same as in the corona of solar eclipses, and in the zodiacal light, but never identified with a spectrum line of any terrestrial substance. Two dark and apparently absorptive lines were also seen traversing a continuous white band. Transiently and but once a red line appeared in the spectrum of the east only; and not then unless the instrument was so turned as to lose the green. When observed, about 8 o'clock, the magnetic needle was much disturbed; and the telegraph operated with great difficulty or interruption.

It is worth noticing in the foregoing account, and in certain other foreign descriptions, that the aurora of October, 1870, is referred to as a parallel, in its main characteristics, with this of 1872. Also that this last is spoken of as unequalled in variety and completeness, even by the great displays of 1831–36. In these respects, however, there appears little, if anything, to exceed, either in scope or magnificence, a few which the writer has witnessed in northern New England and even here, at times—excepting only the peculiar and novel south developments. But, although in a different mode of manifestation, the phenomena of 1870 and 1872 were, evidently and equally as real and grand an anomaly to the other continent as, in a different way, they have been to our own.

But the fact of a sympathy, and even of a oneness, in and between the distant manifestations is not purely conjectural. As an illustration, Professor E. T. Quimby of Dartmouth College, New Hampshire, in this instance, observed the magnetic needle during much of the day of February 4th. His chart of the curve of disturbance is in possession of Prof. H. A. Newton, who has brought it to the writer's notice. It manifests a surprising amount of disturbance—beginning, in a marked degree, at 10 o'clock A. M. The north end of the needle then pointed 13′ east of the normal variation. In eleven minutes the varia-

tion had increased to 50′, where it remained unsteadily for six minutes, and thereafter advanced to 65′ increase at $10^h\ 20^m$. Resting about at this four minutes, it suddenly reached an an eastern variation of 93′, and, at $10^h\ 26^m$, of 113′. Declining back however, in 1^m to 82′, it kept traversing, through a range of 10′, at about that average till $10^h\ 35^m$, when observation was suspended an hour and eighteen minutes. On renewed observation, at $11^h\ 53^m$, the same was found at 133′ eastern deviation. It started on in $1\frac{3}{4}^m$ to 173′, and so traversed till just before noon. At 1^m before 12 o'clock it started on to 193′, and traversing through a back and forward range of 18′, advanced, at $12^h\ 6^m$ P. M., to 313′, and, at $12^h\ 7^m$, to 323′. At this instant the north end of the needle—which has, normally, 11° of declination W. at that locality (Hanover)—had varied to its eastward extreme, and to the unwonted extent of 5° 23′. It deserves notice that it was but a few minutes after this maximum in absolute time, that the phenomenon was observed to be established in England and at Cologne, and probably it had become established in fact before it. From this extreme the needle fell back 30′ in less than five minutes, and began, three minutes still later, to fall back yet more, and, at $12^h\ 20\frac{3}{4}^m$, to a minimum of 113′, but rallied to 298′ at $12^h\ 22\frac{1}{8}^m$. It found a second minimum of 83′ at $12^h\ 28^m$, and a third of 53′ at $12^h\ 37\frac{1}{4}^m$, and a maximum of between 293′ at $12^h\ 35\frac{3}{4}^m$. It gradually came to a normal position at 2 o'clock, and in after instances deviated to the west. The extreme western deviation was 17′ at 3^h; but at 9^h, and for a quarter of an hour later, the deviations were east, about 48′. It will be seen from the above that there were three epochs of extreme and sudden deviation followed by as many of sudden change back again,—that the extreme fluctuation was 5° 40′ in three hours time, and that the violent disturbance preceded the *visible*, although perhaps not the actual, phenomena.

Reverting, in conclusion, to the enquiry concerning the actual *height* of the zone of 1872, although the early observations at Hudson, New Haven, and Haverford, as already admitted, are not favorable for its determination, yet it is evident, on a review of all the observations, that at the two places last named the very latest are so nearly coincident as to time, and so favorable as to situation in azimuth and altitude, as to be available for the object. In fact, having the distance between those stations (158·7 miles) as a base, and the azimuth of the base 54° W. of S. from New Haven, and the observed point of the zone at the star Sirius, the parallax is found by measurement on the globe to be 9° 5′. The oblique azimuthal angle at New Haven is found 36° 40′, and the corresponding zenith distance 65° 10′, and the zenith distance at Haverford 57° 28′.

The computed result is, rigorously, 352·25 miles of height above the earth's surface. The distances of the point observed from the two stations were respectively 720·08 miles and 600·31 miles. This ascertained height, like the same found for the similar zone of 1870 (339 miles), is, no doubt, extraordinary; but, considering the novelty of these zones in other particulars, and the now more advanced state of knowledge respecting auroras, it is less surprising than were the several far lower heights deduced by the author from observations in 1835 and 1836, but received then and for a time with incredulity.* The great circle of the zone of 1870 is cut by the great circle of the zone of 1872 in A. R. 77° and S. Dec. 14½°, and at the corresponding opposite point; but the latter is inclined to the former 24° north.

ART. XXXVIII.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XX.—*Recent Additions to the Molluscan Fauna of New England and the adjacent waters, with notes on other species;* by A. E. VERRILL.

[Continued from page 209.]

Spiralis balea (Möll. sp.) = *Heterofusus balea* Mörch; Binney, = *Spiralis Gouldii* Stimpson.

Heterofusus Alexandri V. = *H. Flemingii* Binney (non auth.).

Taonus pavo Stp. = *Loligopsis pavo* Fer. and D'Orb.; Binney (description) = *Loligo pavo* Les.; but not the *figure* (pl. xxvi), which is an *Ommastrephes* (? *O. illecebrosa*).

Ommastrephes illecebrosa (Les. sp.) = *O. sagittatus* Binney (description), but not the figure (pl. xxv, fig. 340), which is a *Loligo* (? *L. Pealii*, female).

Loligo = *Ommastrephes Bartramii* Binney (non Les. sp.). The figure (pl. xxv, fig. 339), represents a *Loligo*, but does not show the long tentacular arms.

Descriptions of Genera and Species.

Scalaria angulata Say, Amer. Conch., 1831, = *S. Humphreysii* Kiener, 1838.

Say described this species as a doubtful variety of *S. clathrus*, under the above name, which should, therefore, be adopted instead of Kiener's.

Acirsa borealis Mörch (Beck sp.).

Shell white or pale flesh-color, elongated, turreted, acute. Whorls ten, convex, with numerous revolving striæ; the upper

* This Journal, I, vol. xxxii, page 217.

whorls with slight transverse undulations or faint costæ, which are wanting on the lower ones; last whorl slightly carinated. Aperture roundish, effuse and slightly angulated in front.

Length about ·75 of an inch; diameter ·28.

Eastport, Me., shelly bottoms, 10 to 40 fathoms, dead shells frequent, rarely living,—A. E V. and S. I. Smith.

Lunatia heros, var. triseriata.

Since there are no positive characters by which the *Natica triseriata* Say can be distinguished from *heros*, except the color, —a character well known to be very unreliable in this family, —I have for several years suspected that the two forms were but varieties of one species. The size and outlines are generally described as different, but the shape varies in both, passing through the same series of forms, while specimens of the *triseriata* type, although usually smaller, are sometimes found as large as the full-grown *heros*.

This view was fully confirmed two years ago at Eastport, by breaking up large and characteristic specimens of *L. heros*, when in one such specimen the inner whorls were found to have the distinct color markings of the *triseriata*. This specimen was a well-marked *triseriata* until half-grown, when it changed to *heros!*

The two varieties are associated and have the same range, being common everywhere on sandy shores from the Gulf of St. Lawrence to Cape Hatteras, and probably farther south.

Aclis polita V., sp. nov. Plate VI, figure 5.

Shell white, elongated, regularly tapering, slender, acute. Whorls thirteen or more, convex, rounded, scarcely flattened; surface smooth, polished, shining, with faint or scarcely distinct striæ of growth. Aperture broad oval; outer lip sharp, slightly effuse; columella slightly curved, without a fold. Length ·33 of an inch; breadth ·08.

Eastport Harbor, 20 fathoms, shelly bottom. Only one perfect specimen was obtained.—Exp. 1864, A. E. Verrill and S. I. Smith.

Turbonilla elegans V., sp. nov. Plate VI, fig. 4.

Shell light yellowish, elongated, moderately slender, acute. Whorls ten or more, well rounded, not distinctly flattened; suture rather deeply impressed; surface somewhat lustrous, with numerous rounded vertical costæ, narrower than the concave interspaces, fading out below the middle of the last whorl; and with numerous fine revolving grooves, which are interrupted on the costæ, but distinct in the intervals; on the upper whorls there are about five; and on the lower half of the last whorl usually five or six distinct and continuous ones.

Aperture broad oval, anteriorly rounded and slightly effuse; outer lip thin, sharp; columella nearly straight at base within, slightly revolute outwardly, regularly curved anteriorly where it joins the outer lip, and not forming an angle with it. The epidermis is thin, light yellow, sometimes with a darker, yellowish revolving band on the middle of the last whorls, and also with the revolving striæ darker.

Length ·22; breadth ·07 of an inch.

Several living specimens were dredged in Vineyard Sound, in 8 to 10 fathoms, shelly bottom,—A. E. Verrill and S. I. Smith (on U. S. Fish Commission).

This species is allied to *T. interrupta*,* but is less slender and has the whorls more rounded. The sculpture is nearly the same.

Stylifer Stimpsonii V., sp. nov.

Shell white, short, swollen, broad oval; spire short, rapidly enlarging. Whorls four or five, the last one forming a large part of the shell; convex, rounded, with the suture impressed, surface smooth, or with very faint striæ of growth; a slightly impressed revolving line just below the suture. Aperture large and broad. Length about ·15 of an inch; breadth ·12. I have seen no specimens with the aperture perfect.

Off the coast of New Jersey, on a bank in 32 fathoms, parasitic on *Euryechinus Dröbachiensis* V.,—Capt. Gedney.

Cæcum costatum V. Plate VI, fig. 6.

Cæcum Cooperi Smith, Annals Lyceum Nat. History, vol. ix, p. 394, fig. 3, 1870, (non Carpenter).

Mr. Sanderson Smith has described and figured this shell in a later stage of growth than the one here figured. In my figure the longitudinal costæ are, by an error, not so distinctly brought out as they should be, and the annular grooves in the depressions are too distinct.

In the adolescent stage of growth this species enlarges rather rapidly, and has 12 or 13, distinct, elevated, rounded costæ, narrower than the intervals between; the circular grooves are numerous, unequal, interrupted over the costæ, and broader toward the aperture. The aperture is rounded within; its margin is externally stellated by the costæ.

Vineyard Sound, 8 to 10 fathoms,—A. E. V.; Gardiner's Bay, L. I., 4 to 5 fathoms, sand,—Smith.

ELYSIELLA, gen. nov.

Allied to *Elysia* and *Placobranchus*. Head rounded, with two short, obtuse tentacles; eyes sessile behind the bases of the tentacles, on the neck. Lateral lobes united behind, rounded

* The figure in Gould's Invertebrata (copied in the new edition) is very poor.

and separate in front, and raised from the back, leaving a cavity beneath for respiration. Blood vessels, commencing in the anterior part of the back, extend backward, forking and diverging, in the area enclosed by the lateral lobes.

This genus differs from *Placobranchus* and *Elysia* in having the lateral lobes united together posteriorly over the back, so that the respiratory cavity partially enclosed by them is closed behind.

Elysiella catulus V. Plate VII, figures 5, 5ª.

Placobranchus catulus Agassiz, MSS.; Gould, Invert. of Mass., 2nd ed., p. 256, pl. xvii, figs. 249, 250, 1870.

This species is well described by Dr. Gould, but the figure is incorrect in representing the lateral lobes as separate posteriorly,—perhaps a theoretical mistake on the part of the artist.

It is common adhering to eel-grass in harbors and estuaries from Boston to New Jersey; Great Egg Harbor,—A. E. V. and S. I. Smith; New Haven, Conn., and Wood's Hole, Mass., —S. I. Smith.

It often floats with the bottom of the foot at the surface of the water.

Styliola vitrea V., sp. nov. Plate VI, figure 7.

Shell smooth, polished, diaphanous, almost glassy, long conical, rather slender, slightly curved toward the acute apex. Animal white; swimming organs obovate, with the end broadly rounded, and bearing the slender tapering tentacles near the middle of the anterior edge; intermediate lobe short, rounded in front.

Length of shell ·46; diameter ·08 of an inch.

This species was taken among *Salpæ*, off Gay Head, Martha's Vineyard, in the afternoon, Sept. 9th, 1871,—Dr. A. S. Packard and A. E. Verrill.

Ensatella Americana (Gould sp.)

Solen ensis of American authors, not of Linnæus.

In addition to the differences in the shells of the American and European species, noticed by Gould and others, there are, apparently, still more marked differences in the soft parts, to judge from the figures and descriptions of the *ensis* of Europe.

In our species, when full grown, the siphonal tubes protrude an inch or more and are united for about half their length, beyond which they are round and divergent, subequal. Both orifices are surrounded by a similar circle of numerous papillæ, of three sizes; the larger ones are enlarged in the middle, acute at tips, with a large black spot on each side of the base; alternate with these are somewhat smaller ones of the same form and with similar basal spots; alternating with the primary and sec-

ondary ones are small tapering papillæ, less than half the length of the longest; numerous slender tapering papillæ are also scattered irregularly over the sides of the free portions of both tubes, in some cases in irregular rows of four to six, while on the ventral side of the branchial tube two rows of alternating papillæ extend along the whole length of the siphon. The mantle is open ventrally for more than half its length; the posterior portion of the opening has small conical papillæ along its margin. Foot long; the end bulbous, obliquely truncated and beveled laterally.

Periploma papyracea V. Plate VII, figs. 1, 1ª, 1ᵇ; pl. VIII, fig. 1.

Anatina papyracea Say; Gould, Invert. Mass., 2nd ed., p. 67, fig. 382.

An examination of the soft parts of this species (pl. viii, fig. 1) shows that it is very different from *Anatina*, and agrees closely with *Periploma*, with which the shell also agrees well.

The siphonal tubes are separate from the base, slender, subequal; the orifices are both surrounded by a simple row of small papillæ. One pair of gills, with a well-marked longitudinal fold on the dorsal side posteriorly. Palpi with the anterior and ventral margin thickened, revolute, and strongly striated transversely, the ends prolonged and rolled into a point posteriorly. Mantle with thickened margins, united except at the small antero-ventral opening for the foot.

In young shells (pl. vii, fig. 1ª) the spoon-shaped tooth is supported beneath by two slender brace-like laminæ, in both valves; in larger shells one of these usually becomes obsolete.

This species occurs from New Jersey to Labrador.

Angulus modestus V., sp. nov. Plate VI, figures 2, 2ª.

Shell smooth, shining, more or less iridescent, with very fine concentric striæ. Form similar to that of *A. tener*, but more oblong and with the anterior dorsal margin nearly straight or even slightly concave; the beaks are at about the posterior third, and scarcely prominent; the posterior end slopes rapidly, and is subtruncate at the end; the ventral margin is but slightly convex in the middle, and sub-parallel with the dorsal margin. The shell is often a little thickened and firmer than in *A. tener*, but is sometimes as thin. Color pink, light straw-color, or white; often banded concentrically with these colors. The hinge margin is stouter and the teeth stronger than in *A. tener*, and different in relative size and proportions, as may be seen by comparing the figure (pl. vii, fig. 1) with that of *A. tener* (fig. 2) magnified to the same extent. The ligament plate is also longer.

This species occurred sparingly in Vineyard Sound and Buzzard's Bay, in 6–10 fathoms, sand,—A. E. V. and S. I. Smith; it has also been found in Long Island Sound, off New Haven, 4–5 fath., mud,—A. E. V.

GASTRANELLA V., gen. nov.

Shell oblong, more or less irregular, and sometimes with the ventral margin inflexed; pallial sinus large; ligament external, elongated. Right valve with two small cardinal teeth; the posterior one thin, directed obliquely backward. Left valve with two cardinal teeth; the posterior one stout, bilobed; the anterior one smaller. No distinct lateral teeth. Animal with long, slender, separate siphonal tubes, with a simple circle of papillæ at the ends; mantle well open anteriorly; foot ligulate. The curious little shell for which this genus is constituted apparently resembles *Gastrana* more than any other described genus.

Gastranella tumida V., sp. nov. Plate VI, figures 3, 3a.

Shell small, variable in form, swollen above, more or less elongated oval, or oblong, with rounded ends, compressed posteriorly. The beaks are rounded, somewhat prominent, incurved but not approximate, and directed somewhat forward; the anterior dorsal margin is deeply concave in front of the beaks, but without a distinct lunule, at the anterior end regularly rounded or a little prolonged, compressed; ventral margin slightly convex, or nearly straight and sub-parallel with the dorsal margin, or incurved, in the different specimens; posterior end broadly rounded in some, decidedly prolonged in others; dorsal posterior margin usually nearly straight for at least half its length, sometimes a little convex and gradually sloping throughout. Surface with fine, somewhat irregular, concentric striæ, slightly iridescent. Color white, with the umboes purple. Long Island Sound, near New Haven, 4–6 fathoms, shelly and gravelly bottom, among hydroids and sponges,—A. E. Verrill.

This species appears to be a "nestler," and quite variable in form. About 20 specimens were obtained, of different sizes; one of the largest, which may not be mature, is ·18 of an inch long, ·09 high and about the same in thickness.

Turtonia nitida V. Plate VII, figures 4, 4a.

Turtonia minuta Gould, 2d ed., p. 85, fig. 395 (not of European authors).

The American specimens of this shell differ so widely in form and especially in the structure of the hinge, from all the European specimens with which I have compared them, as well as from the descriptions and figures, that I cannot regard them as identical. Dr. Gould has well defined the form and external characters of our shell. The much enlarged figure of the interior, which is now given, illustrates the structure of the hinge better than any description could. I have seen no European specimens so elongated in form as the American examples seen by me invariably are, but depend less on the external form than on the structure of the hinge for distinguishing them.

Astarte undata Gould, Inv. Mass., 1st ed., p. 79, 1840 (provisional name).

Astarte sulcata (pars) Gould, op. cit., and most American writers.
Crassina latisulca Hanley, Recent Bivalve Shells, p. 87, pl. 14, fig. 35, 1843.

This is by far the most abundant species on the northern coast of New England. It ranges from Cape Cod to Labrador. In the Bay of Fundy it is very abundant at all depths, from 3 to 125 fathoms, on muddy bottoms. It varies greatly in form and sculpture, but can easily be recognized in all its varieties, by any one familiar with the species of this genus. The beaks are less prominent and the lunule less deeply excavated than in *A. sulcata*, and other differences exist in the hinge, etc.

The figure in the new edition of Gould (fig. 432) is not characteristic, having been made from an old eroded specimen, of unusual, if not abnormal, form.

Astarte lens Stimpson, MSS.

Astarte crebricostata Gould, 2d ed., p. 126, fig. 440 (non Forbes).

This species is very well described and figured in the work referred to. It is unquestionably distinct from the *A. crebricostata* of Europe. It occurs associated with the preceding species in Eastport Harbor and the Bay of Fundy on soft muddy bottoms in 20 to 130 fathoms. This, however, is much more common at 100 fathoms and below, being by no means abundant at 20–30 fathoms, where the former occurs in the greatest profusion.

The two species, although somewhat similar, are easily recognized. This is more compressed, more rounded, lighter and brighter yellowish in color, and generally has much more numerous and regular undulations. The hinge is also quite different.

Astarte quadrans Gould, 1st ed., p. 81; 2d ed., p. 123, fig. 434.

Astarte Portlandica Mighels, Boston Jour. Nat. Hist., iv, 320, 345, Pl. 16, fig. 2.

Among the specimens dredged in Eastport Harbor are some that agree with the original *Portlandica*, in color, form, and size, while other specimens are intermediate between these and the typical *quadrans*, so that a complete series can be formed connecting the two varieties together. Differences of the same kind and equally great occur in other species of *Astarte*.

Cryptodon obesus V., sp. nov. Pl. VII, fig. 2.

Shell white, irregularly and rather coarsely concentrically striated, much swollen in the middle; the transverse diameter nearly equal to the length; the height considerably exceeding the length. The beaks are prolonged and turned strongly to the anterior side. The lunular area is rather large and sunken, somewhat flat, in some cases separated by a slight ridge into an inner and an outer portion. Anterior border with a prominent rounded angle; ventral margin prolonged and rounded in the middle; posterior side with two strongly developed flexures,

separated by deep grooves. Interior of shell with radiating grooves, most conspicuous toward the ventral edge.

Length of the largest specimen ·60 of an inch; height ·72; thickness ·52. The smaller specimens have about the same proportions.

Off No-man's Land, in 19 fathoms, muddy bottom,—A. E. V. and Dr. A. S. Packard; Labrador,—Dr. Packard.

Six single valves, some of them quite fresh, were obtained off No-man's Land at several different localities. They were all right valves, and the smallest was ·50 of an inch in height. The specimen from Labrador agrees nearly in form and structure, and is only ·23 in height and ·20 in length.

This species appears to be more nearly related to *C. flexuosus* of Europe than to *C. Gouldii*. The European species is nearly intermediate between the two American shells in form; but judging from the specimens which I have had opportunities to examine, the three forms ought to be kept distinct. *C. Gouldii* is common in Eastport Harbor, and occurs sparingly in Buzzard's Bay and Vineyard Sound. It is a thinner and more delicate shell, more rounded, relatively much longer, and is seldom more than ·25 to ·30 of an inch in breadth.

Anomia glabra V.

Anomia ephippium (pars) Linn.; Gould and most American authors.
A. electrica Binney, in Gould, 2d ed., p. 205, fig. 499 (*non* Linn.).
A. ephippium Binney, op. cit., p. 204, fig. 497 (*non* Linn.).

One of the localities given by Linné for *A. ephippium* was "Pennsylvania." He, therefore, doubtless included our common southern *Anomia* under that name, but it appears to be quite distinct from the common European species. Its range is quite southern. It is very abundant everywhere from Cape Cod to Florida, but north of Cape Cod it is rare. Although occasionally found as far north as Nova Scotia, I have never met with it at Eastport or in the Bay of Fundy, where it is replaced by the typical *A. aculeata* and its squamose variety.

Glandula arenicola V., sp. nov.

Body sub-globular, rather higher than broad, the whole surface covered with grains of sand forming a continuous layer. When the sand is removed the surface of the test is reticulately wrinkled and pitted, not furnished with fibres, except at base, where there are a few long, slender, thread-like, white ones. Tubes terminal, near together, in the alcoholic specimen short, forming low verrucæ, swollen at base, the ends a little prominent and naked. Apertures square, with four small lobes. The test is tough and opaque. Height ·45; breadth ·35 of an inch.

Murray Bay, Gulf of St. Lawrence,—Dr. J. W. Dawson.

Molgula pellucida V. Plate VIII, figure 2.

Body sub-globular with a smooth, thin, pellucid test. Tubes terminal, contiguous, much swollen at base, long, divergent, tapering, reticulated within by longitudinal and circular white lines (muscular fibers). Branchial aperture with six small papillæ. Intestine conspicuously visible through the test; stomach covered by deep orange-colored hepatic glands. Ovaries large, whitish. Color of test, pale hyaline bluish; tubes toward the ends, dull neutral tint.

Diameter of the largest specimens about 1 inch.

Mass. Bay,—L. Agassiz; Long Island,—Coll. Peabody Academy of Science; Bird Shoal near Beaufort, N. C.,—Dr. H. C. Yarrow.

Mr. Binney has published characteristic colored figures of this species under the name of *M. producta* Stimp., which is a very different, sand-covered species, (plate viii, fig. 6).

Eugyra glutinans V.

Cynthia glutinans Möll., Naturh. Tidsskrift, iv, p. 94, 1842.

Several specimens from Greenland, which I have had opportunity to examine, were sent by Dr. Chr. Lütken to Dr. A. S. Packard as Möller's species, and agree well with his description.

These are subglobular, ·20 to ·35 of an inch in diameter, with a thin translucent test, covered with fine sand, which adheres to very slender and delicate fibers which thickly cover the whole surface, but are longer and more numerous below, those of the base being as long as the diameter of the body and bearing grains of sand along their whole length. The tubes are naked and entirely retractile, connected by a thickened ridge surrounding their bases. The branchial aperture is six-lobed; the anal is square. It is more nearly allied to *E. pilularis* V. than to any other American species.

Ascidiopsis complanata V., gen. nov. Plate VIII, fig. 8.

Ascidia complanata Fabr.; Verrill, this Journal, i, p. 98, fig. 11, 1871.
Ascidia callosa Stimp., Proc. Boston Soc. Nat. Hist., vol. iv, p. 228, 1852.

The remarkable and complex structure of the gill in this species seems to require its separation as a distinct genus. A small portion of the gill is represented in the figure, much enlarged.

Alcyonidium ramosum Verrill, sp. nov. Plate VIII, fig. 10.

Much branched, when full grown; the branches irregularly dichotomus, usually crooked. Surface glabrous, smooth, or nearly so, the cells rather small and crowded; zooids with sixteen slender tentacles. Color ashy brown, or dull rusty brown.

Diameter of branches mostly ·20 to ·25 of an inch. Height 10 to 15 inches.

Off South-end, near New Haven, 1–4 fathoms, common, —A. E. V.; Vineyard Sound, Mass. and Great Egg Harbor, N. J.,—A. E. V., and S. I. Smith.

Errata.—p. 210, for *Mangelia cerinum*, read *Mangelia cerina*.

EXPLANATION OF PLATES.

PLATE VI.

Figure 1. *Angulus tener*, enlarged 5 diameters; 1 *a*, the same, natural size (from Binney's Gould, by E. S. Morse).
" 2. *Angulus modestus* V., enlarged 5 diameters; 2 *a*, the same, natural size.
" 3. *Gastranella tumida* V., enlarged 16 diameters; 3 *a*, another specimen, enlarged 6 diameters.
" 4. *Turbonilla elegans* V., enlarged 5 diameters.
" 5. *Aclis polita* V., enlarged 5 diameters.
" 6. *Cæcum costatum* V., immature, enlarged 24 diameters.
" 7. *Styliola vitrea* V., enlarged 3 diameters.

PLATE VII.

Figure 1. *Periploma papyrcea*, left side, exterior view (from Binney's Gould, by E. S. Morse); 1 *a*, the same, view of the interior of a young specimen, with the ossicle in place, enlarged 3 diameters; 1 *b*, ossicle of the same, enlarged 30 diameters.
" 2. *Cryptodon obesus* V., enlarged 3 diameters.
" 3. *Modiola hamatus* (young), from New Haven, enlarged nearly 2 diameters.
" 4. *Turtonia nitida* V., view of the interior, enlarged 40 diameters; 4 *a*, the same, external view, natural size and enlarged, (from Binney's Gould, by E. S. Morse).
" 5. *Elysiella catulus* V., dorsal view, enlarged nearly 3 diameters; 5 *a*, the same, ventral view, more enlarged.

PLATE VIII.

Figure 1. *Periploma papyracea*, animal, resting in right valve, with part of the mantle removed from the upper side; *a*, retracted anal tube; *b*, branchial tube; *g*, left gill; *m*, *m*, anterior and posterior adductor muscles; *i*, intestine; *l*, liver; *p*, palpi of left side; *f*, retracted foot; *o*, opening in mantle for protrusion of foot.
" 2. *Molgula pellucida* V., rather more than natural size.
" 3. *Eugyra pilularis* V., enlarged about 2 diameters, with the adhering mud partly removed.
" 4. *Molgula papillosa* V., from off Martha's Vineyard, enlarged 2 diameters, with the adhering sand mostly removed.
" 5. *Molgula arenata* Stimp., natural size, and with its coating of sand.
" 6. *Molgula producta* Stimp., natural size, with its coat of fine sand.
" 7. *Cynthia partita* Stimp., erect variety, showing the outline and the character of the apertures; but the surface of the body appears smoother than is natural.
" 8. *Ascidiopsis complanata* V., small portion of the gill, much enlarged.
" 9. *Pera crystallina* V., from Murray Bay, enlarged 3 diameters.
" 10. *Alcyonidium ramosum* V., a young specimen enlarged 2 diameters, with part of the zooids expanded.

ART. XXXIX.—*Discovery of the Dermal Scutes of Mosasauroid Reptiles;* by Professor O. C. MARSH.

THE great abundance of *Pythonomorpha* in the Cretaceous deposits of this country is rapidly affording material for a full understanding of the structure of these peculiar reptiles, about which, until recently, so little has been known. The explorations of the Yale College party in Western Kansas, in 1870, first proved the existence of posterior limbs, in three of the

genera,* and the same party, during their investigations of the past year in that region, have added several other important facts, one of which is, that these reptiles were protected by osseous, dermal plates, a point of much interest in determining their true affinities. An examination of a large number of specimens has shown that this covering existed in *Edestosaurus*, *Liodon*, *Holcodus* and *Clidastes*, and hence there can be little doubt that it was common to the entire group.

The plates were first observed in a specimen of *Edestosaurus*, on which several were adhering to portions of the skull and lower jaws. A few of these were attached together, apparently in their original position with reference to each other, thus indicating their natural arrangement. There were evidently at least two or three kinds of scutes, and all of those preserved are essentially quadrilateral in form, the posterior margin being the shortest. The lower surface is smooth. The upper side has the margin more or less beveled, to admit an imbricate arrangement when in place, but no true ornamentation. The edges are, in general, quite thin, but one shows that it was united by suture. There are also indications of an imperfect articulation, somewhat like that seen in the plates of some species of *Palæoniscus*.

The exact arrangement of the scutes when in place is difficult to ascertain from the limited number of specimens observed, but a complex pattern was evidently produced by alternate rows of scutes of different shape and size. In some places, the edges overlapped in such a way as to bring three thicknesses together. The position in which the plates were found would indicate that they were mainly from the lower part of the neck.

Measurements.

Length of large scute of *Edestosaurus*,	28· mm.
Width at anterior margin,	27·
Width at posterior margin,	9·
Greatest thickness,	3·
Length of small scute of *Edestosaurus*,	18·
Width at anterior margin,	18·
Width at posterior margin,	12·
Greatest thickness?	1·5

In the genus *Liodon*, the scutes are also imbricate, and somewhat similar to those above described; but all observed appear to be proportionally smaller. Those found with one specimen are quadrilateral in form, with the posterior margin shortest. They are smooth below, but the upper surface is rugose. The exposed portion is linguiform, with its longer axis corresponding to that of the scute. One perfect scute was 26 mm. in length, 20 in average width, and 4·25 in thickness. The scutes in *Holcodus*,

* This Journal, vol. i. p. 447, June, 1871.

so far as observed, resemble those of *Liodon*. In *Clidastes*, the only scutes detected were some fragments adhering to the caudal vertebræ of *C. Wymani* Marsh. They are very thin, and quite smooth.

The various specimens examined in this investigation render it probable that the cranium of these reptiles was not covered with plates, but the body only, as in some of the Crocodilia. The scutes are apparently different in each species, and hence are important as a means of identification.

Yale College, New Haven, March 5th, 1872.

ART. XL.—*A New Method of Estimating the Sun's Mass and Distance, by means of the Heating Energy of Flames;* by PLINY EARLE CHASE, Professor of Physics in Haverford College.

IN a recent paper* I endeavored to demonstrate, from familiar postulates, the following proposition:

The kinetic energy of dissociated water should be to the kinetic energy of terrestrial revolution, as the mass of the earth is to the mass of the sun;

And *the energy of hydrocarbons should be to the energy of dissociated water, as elastic energy, under constant volume, is to elastic energy under constant pressure.*

As the proposition has obvious important bearings, I submit to the readers of this Journal the following illustrations of my method.

Various experimenters have estimated the heating equivalents of chemical combination, for hydrogen and other elementary and compound substances. The earlier estimates are very discordant, but successive improvements in apparatus led to a satisfactory approximation of results.

Molecular, as well as cosmical forces, being presumably central, the hypothesis that chemical forces vary as gravitating energies does not seem unreasonable. Stephenson and Herschel, nearly a half century ago, spoke of our various forms of fuel as containing, within themselves, solar energies which had been stored up during the processes of organization. The experiments, to which I have just referred, gave approximate measurements of those energies, but I am not aware that any one, previous to the appearance of my barometrical and magnetical discussions,† attempted to show any direct and commensurable relation, between any forms of cosmical and molecular force.

In Muspratt's Chemistry, I find, among other estimates of the

* Read before the American Philosophical Society, Feb. 16, 1872.

† Proceedings and Trans. Amer. Phil. Soc.; this Journal, 1863–4, et sub.

heating energy of Hydrogen, the reasonably accordant ones of Andrews, Dulong, Favre and Silbermann, Grassi, and Hess. According to the mean of their several results, one pound of H, burned with eight pounds of O, liberates enough heat to lift the nine pounds of gaseous H_2O *in vacuo*, $\frac{34533 \times 772}{9}$ feet.

If such a lift were accomplished, it would establish an oscillation, which would be perpetually sustained by terrestrial attraction and elastic rebound, if not counteracted by opposing forces.

Let h= mean height of oscillating vapor ($\frac{1}{2} \times \frac{34533 \times 772}{9}$ feet).*

m= mass of sun, in units of the earth's mass.

d= mean distance of sun in units of earth's equatorial radius =mean height of oscillating earth.

y_0= $365^d\ 5^h\ 48^m\ 49^s$.

y_1= time of satellite revolution at earth's equatorial surface $= 2\pi\sqrt{\frac{r}{g}}$.

r= earth's equatorial radius (20,923,654 feet=mean of Airy and Bessel.)

g= 32·08744.

According to my hypothesis

$$h : rd :: 1 : m \therefore m = \frac{rd}{h}.$$

We have also, according to well known mechanical laws, $m = \left(\frac{y_1}{y_0}\right)^{\frac{2}{3}} \times d^3$. Solving the equations, we obtain the following values (C), which I collate with the careful astronomical estimates of Newcomb (N), and Stone (S).

	C.	N.	S.
Mass of the sun,	330,260	326,800	329,000
Distance " "	92,639,500 m.	92,380,000 m.	91,945,000 m.

If an elastic fluid is lifted above the earth's surface, subject to the (nearly) constant pressure of gravity;

The superficial pressure $\propto \left(\frac{r+h}{r}\right)^2$.

And the volume $\propto \left(\frac{r+h}{r}\right)^3$

Therefore, under equal increments of heat,

vol. under const. press. : const. vol. $\times (r+h)^3 : r^3$.

In the case of H_2O, from the values already adduced, we obtain $\left(\frac{r+h}{r}\right)^3 = 1{\cdot}488$. This corresponds, approximately, to

* My theoretical mean specific heat of H_2O being $\frac{1}{3}$.

the experimental valuation adopted by Tyndall (1·421), and is virtually identical with the mean result of the experiments of Dulong, and Favre and Silbermann, upon ether and olive oil (1·494 and 1·495), as well as with the theoretical volumetric condensation of H_2O (1·5).

If my postulates are admitted, the field which they open for the verification of astronomical, thermal, electrical and chemical observations and experiments, seems unlimited. I have already in view special researches pertaining to solar temperature, æthereal density, atomicity and valency, specific and latent heats, temperature of fusion, vaporization and dissociation, mixtures of gases and vapors, periods of planetary rotation, terrestrial rigidity and tides.

Philadelphia, Feb. 20, 1872.

ART. XLI.—*The Yellowstone National Park;* by F. V. HAYDEN. With a Map.

IN order that the Park, or reservation, containing within its limits the wonderful falls, hot springs, geysers, and other objects of interest mentioned in our preceding articles may be more clearly understood by the readers of this Journal, we have prepared a map expressly to show the Park with its surroundings; the scale is ten miles to an inch. The Report of the Committee on Public Lands, as well as the law itself, which are appended to this article, will serve to explain the map in general terms.

A glance at the map reveals to the reader the geographical locality of one of the most beautiful lakes in the world, set like an emerald among the mountains. It will be seen also that the mountains that wall it in on every side, form one of the most remarkable water-sheds on the continent. The snows that fall upon their summits give origin to three of the largest rivers in North America. On the north side are the sources of the Yellowstone; on the west side those of the Three Forks of the Missouri; on the southwest and south those of the Snake river flowing into the Columbia and thence into the Pacific Ocean, and those of Green river rushing southward to join the great Colorado, and finally emptying into the Gulf of California; while on the east are the numerous sources of Wind river. From whatever point of view we survey this remarkable region, it is unsurpassed in interest.

On the 18th of December, 1871, a bill was introduced into the Senate of the United States, by the Honorable S. C. Pomeroy, to set apart a certain tract of land lying near the headwaters of the Yellowstone river, as a public park. About the

same time a similar bill was offered in the House of Representatives, by Hon. Wm. H. Claggett, the delegate from Montana. After due consideration in the Committee on Public Lands in both Houses, the bill was reported favorably. In the Senate it was ably advocated by Messrs. Pomeroy, Edmunds, Trumbull, and Anthony. In the House, the objects of the bill were so clearly and forcibly set forth in the remarks of Hon. H. L. Dawes, that it was voted upon at once, and passed.

The above is a brief history of an event which marks an era in the scientific progress of the country. That our legislators, at a time when public opinion is so strong against appropriating the public domain for any purpose, however laudable, should reserve for the benefit and instruction of the people a tract of 3,575 square miles, is an act that should cause universal satisfaction through the land. This noble deed may be regarded as a tribute from our legislators to science, and the gratitude of the nation, and of men of science in all parts of the world, is due them for this munificent donation.

Mr. Dunnell, from the Committee on the Public Lands, made the following Report.

The bill now before Congress has for its object the withdrawal from settlement, occupancy, or sale, under the laws of the United States, a tract of land fifty-five by sixty-five miles, about the sources of the Yellowstone and Missouri Rivers; and dedicates and sets it apart as a great national park or pleasure ground for the benefit and enjoyment of the people. The entire area comprised within the limits of the reservation contemplated in this bill is not susceptible of cultivation with any degree of certainty, and the winters would be too severe for stock-raising. Whenever the altitude of the mountain districts exceeds 6,000 feet above tide-water, their settlement becomes problematical unless there are valuable mines to attract people. The entire area within the limits of the proposed reservation is over 6,000 feet in altitude, and the Yellowstone Lake, which occupies an area 15 by 22 miles, or 330 square miles, is 7,427 feet. The ranges of mountains that hem the valleys in on every side rise to the height of 10,000 and 12,000 feet, and are covered with snow all the year. These mountains are all of volcanic origin, and it is not probable that any mines or minerals of value will ever be found there. During the months of June, July and August, the climate is pure and most invigorating, with scarcely any rain or storms of any kind; but the thermometer frequently sinks as low as 26°. There is frost every month of the year. This whole region was in comparatively modern geological times the scene of the most wonderful volcanic activity of any portion of our country. The hot springs and the geysers represent the last stages—the vents or escape pipes—of these remarkable volcanic manifestations of the internal forces. All these springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands

of years for the cunning hand of nature to form. Persons are now waiting for the spring to open to enter in and take possession of these remarkable curiosities, to make merchandise of these beautiful specimens, to fence in these rare wonders so as to charge visitors a fee, as is now done at Niagara Falls, for the sight of that which ought to be as free as the air or water.

In a few years this region will be a place of resort for all classes of people from all portions of the world. The geysers of Iceland, which have been objects of interest for the scientific men and travelers of the entire world, sink into insignificance in comparison with the hot springs of the Yellowstone and Fire-Hole Basins. As a place of resort for invalids it will not be excelled by any portion of the world. If this bill fails to become a law this session, the vandals who are now waiting to enter into this wonderland will, in a single season, despoil, beyond recovery, these remarkable curiosities which have required all the cunning skill of nature thousands of years to prepare.

We have already shown that no portion of this tract can ever be made available for agricultural or mining purposes. Even if the altitude and the climate would permit the country to be made available, not over fifty square miles of the entire area could ever be settled. The valleys are all narrow, hemmed in by high volcanic mountains like gigantic walls.

The withdrawal of this tract, therefore, for sale or settlement takes nothing from the value of the public domain, and is no pecuniary loss to the Government, but will be regarded by the entire civilized world as a step of progress and an honor to Congress and the nation.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., January 29, 1872.

SIR: I have the honor to acknowledge the receipt of your communication of the 27th instant relative to the bill now pending in the House of Representatives dedicating that tract of country known as the Yellowstone Valley as a national park.

I hand you herewith the report of Dr. F. V. Hayden, United States geologist, relative to said proposed reservation, and have only to add that I fully concur in his recommendations, and trust that the bill referred to may speedily become a law.

Very respectfully, your obedient servant,
C. DELANO, *Secretary.*

Hon. M. H. Dunnell, *House of Representatives.*

The committee therefore recommend the passage of the bill without amendment.

An Act to set apart a certain tract of land lying near the head-waters of the Yellowstone river as a public park.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the tract of land in the Territories of Montana and Wyoming, lying near the head-waters of the Yellowstone river, and described as follows, to wit, commencing at the junction of Gardiner's river

with the Yellowstone river, and running east to the meridian passing ten miles to the eastward of the most eastern point of Yellowstone lake; thence south along said meridian to the parallel of latitude passing ten miles south of the most southern point of Yellowstone lake; thence west along said parallel to the meridian passing fifteen miles west of the most western point of Madison lake; thence north along said meridian to the latitude of the junction of the Yellowstone and Gardiner's rivers; thence east to the place of beginning; is hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom.

SEC. 2. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes, for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same, and the construction of roads and bridle-paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and against their capture or destruction for the purposes of merchandise or profit. He shall also cause all persons trespassing upon the same after the passage of this act to be removed therefrom, and generally shall be authorized to take all such measures as shall be necessary or proper to fully carry out the objects and purposes of this act.

Approved, March 1, 1872.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the wave-lengths of Fraunhofer's lines.*—DITSCHEINER has recomputed the values of the wave-lengths determined by himself after again counting the lines upon his ruled plate of glass. The total breadth of the ruled surface was found to be 13·8765 millimeters and the number of lines 3001. Ditscheiner's values, with the corresponding ones as determined by Angström and van der

Willigen, are given in the table below, which is taken from his paper. A comparison of the results of the measurements of these different observers, provided apparently with equally good instruments, will serve to show that the subject is by no means exhausted, and that new series of determinations are required.

	Kirchhoff.	D.	Angstrom.	v. d. Willigen.
B	593	687·41	686·67	687·132
C	694	656·23	656·18	656·557
	711·5	651·71	651·55	651·961
	719·5	649·67	649·45	649·817
	783·5	633·87	633.58	----
	831	623·24	623·14	----
	850	619·26	619·05	619·423
	860	617·14	616·82	617·201
	864	616·37	616·12	616·510
	874·5	614·38	614·05	614·451
	877	613·88	613·55	613·973
	885	612·40	612·11	612·559
	895	610.46	610.13	610·554
	959	597·79	597·70	----
Da	1002·8	589·74	589·49	589·844
Db	1006·8	589·10	588·90	589.230
	1029·4	585·92	585·65	----
	1096·1	576·39	576·20	----
	1103	575·44	575·20	----
	1135	571·17	570·83	----
	1155·7	568·37	568·14	----
	1174 4	566.00	565 77	----
	1200.4	563·93	562·23	562·336
	1207·5	561·65	561·45	561·809
	1218	560·44	560·16	560·599
	1231·6	558·80	558·55	558·933
	1242·5	557·45	557·18	----
	1280	554·21	552·75	553·214
	1303·7	550·80	550.05	----
	1307	550·37	549·65	----
	1324·8	547·81	547·60	548·186
	1337	546·46	546·23	546·551
	1343·5	545·73	545·46	545·813
	1351·3	544·76	544·58	544·946
	1367	543·10	542·88	----
	1389·6	540·60	540·48	----
	1410·5	539·71	538·23	----
	1421·6	537·20	537·05	537.409
	1451	534·20	534·02	----
	1463	532·98	532·75	533·070
	1492·5	529·91	529·70	----
	1500·5	528·39	528·26	----
	1515·5	527.71	527·50	----
E	1523·5	527·13	526·90	527·203
	1542	525·68	525·42	----
	1569·8	523·43	523·23	523.520
	1577·5	522.79	522·64	522·968
	1589·1	521·69	521·50	----
	1601·6	521·01	520·75	----
	1622·4	519·37	519·18	----
	1634	518·43	518·31	518·605
b	1648·8	517·40	517·22	517·522
	1655·6	516·85	516·68	516·985
	1693·8	514·34	513·85	----
	1737·6	511·12	510·70	----
	1750·4	510·00	509.88	510·199
	1777·4	508·11	507·88	508·268
	1799	506·61	506·40	----
	1834	504·26	504·13	504·390
	1854·5	502·96	502·70	----
	1867	501·97	501·75	----
	1873·5	501·38	501·32	----
	1885·8	500·78	500·50	----
	1908·5	499·43	499·02	----
	1920	498·48	498·20	----
	1961	495·87	495·65	495·979
	1975·6	494·75	494·56	----
	1983	494·05	493·85	----
	1989·5	493·46	493·32	----
	2005	492·03	491·99	492·265
	2018	491·12	491·10	----
	2041·4	489·25	489·05	489·378
	2058	487·89	487·75	----
	2067	487·26	487·10	----
F	2080·1	486·22	486·08	486·400
	2103·3	484·34	483·90	----
	2121·5	482·53	482·24	----
	2148·9	480.28	480.00	----
	2157·4	479·27	479·20	----
	2160·6	478·95	478·86	----
	2187·1	476 53	476·50	----
	2201·9	475·62	475·35	----
	2221·7	474·07	473·60	----
	2233·7	473·08	472·66	----
	2250	471·53	471·35	----
	2264·3	470·43	470·20	----
	2309	466·80	466·65	467·026
	2416	460·36	459·20	----
	2436·5	458·40	458·10	----
	2457·5	456·53	455·50	----
	2467·4	455·45	454·90	----
	2489·4	453·49	453·30	453·632
	2537·1	450·29	450·05	----
	2547·2	449·86	449·40	----
	2566·3	448·20	448·20	----
	2606	445·74	445·40	----
	2627	444·39	444·20	----
	2638·6	443·59	443·45	----
	2670	441·63	441·48	----
	2686·6	440·62	440·40	440·771
	2721·6	438·50	438 40	438·558
	2734·9	437·55	437·51	----
	2775·6	435·42	435·18	----
	2797	434·08	434·00	434·263
	2822·8	432·56	432·50	432·691
G	2854·7	431·12	430·70	431·137
	2869·7	430·13	430·00	430·190
	a	428·96	428·90	----

Kirchhoff.	D.	Angstrom.	v. d. Willigen.	Kirchhoff.	D.	Angstrom.	v. d. Willigen.
A	427·32	427·15	427·477	ν	414·43	414·30	414·544
γ	426·11	426·00	426·002	Γ	413 37	413 20	413·444
ε	425·41	425·05	----	E	410·22	410·01	410·402
δ	424·98	424·95	----	o	408·21	407·70	407·979
$\varepsilon\,\omega$	423·69	423·55	----	π	407·75	407·10	----
B	422·68	422·65	422·876	σ	406·31	406·30	----
ς	421·80	421 50	----	Z	404·52	404·50	404·772
θ	420·13	419·81	----	τ	403·38	402·95	403·615
ι	418·92	418·70	----	ϕ	400·63	400·45	----
χ	417·36	417·20	----	H	396·89	396.80	397·146
μ	415·70	415·40	----	H′	393·53	393·30	393·872

W. G.

2. *On the spectroscopic observation of the rotation of the sun.*—Zöllner and Vogel have succeeded in applying the spectroscope to the measurement of the velocity of the sun's rotation. The first successful observations were made on the 2d of June last under unfavorable circumstances. The subject was resumed on the 9th of June and subsequent days by Vogel and Lohse with complete success, the instrument employed being the reversion-spectroscope of Zöllner attached to the large refractor of the observatory at Bothkamp near Kiel. The slit of the spectroscope was first directed by the aid of the clock-work to the receding edge of the sun, and the coincidence of the D lines in the two superposed spectra effected with the utmost precision. The clock-work was then stopped, and the moment of the disappearance of the second border of the sun observed. The non-coincidence of the D lines at the second border was distinctly seen in all the observations. On June 10th the observat ons were repeated with a highly dispersive spectroscope by Schröder, consisting of five direct-vision prisms and five other prisms arranged in a circle, and made of very heavy glass. The line selected was the fine line (λ=485·917), rather more refrangible than F. The non-coincidence of the image of this line with a fixed steel point was distinctly observed when the light came from the second border of the sun, the coincidence for the first border having been established. By measuring the amount of the displacement, Vogel found for the motion of a point on the sun's equator a velocity of 0·42 (German) miles per second in one series of observations, and 0·35 miles in a second series. These velocities are greater than those at present admitted, and Vogel considers the observations at present as simply demonstrating the fact of the sun's rotation.—*Pogg. Ann.*, cxliv, p. 449. W. G.

3. *Researches on the ammoniacal compounds of Cobalt.*—F. Rose has published in pamphlet form an extended paper upon the ammonia-cobalt bases, containing, besides an elaborate history of the subject, some interesting new facts. By the action of the air upon solutions of cobaltous chloride n ammonia, bes des the chlorides already well known, a dark- and a light-green salt are formed. The dark-green salt dissolves readily in water, at first with a greenish-blue color, which quickly passes to pure blue, and after some time to violet. Chlorhydric acid, with the aid of heat, decomposes this body with formation of chloride of purpureo-cobalt. The author calls this body chloride of dichro-cobalt, in

consequence of its well-marked dichroism. Its formula is, in the old notation employed by Rose, $Co_2Cl_3 . 3NH_3+2HO$, which may be written $\dot{C}o_2Cl_6 . 6NH_3+2\dot{H}_2$, so that it is probably the chloride of cobalt-hexamin. Erdmann has described a corresponding nitrite and Künzel a sulphite; both these salts probably belong to the same series. Rose does not state whether the chloride unites with metallic chlorides to form salts. The light-green salt formed at the same time is identical with the salt discovered by Genth and Gibbs, and called by them praseo-cobalt. The existence of this body was denied by Braun. The salt forms beautiful bright-green crystals, which dissolve in water with a pure green color, which, however, soon passes to rose-red. Strong chlorhydric acid precipitates chloride of purpureo-cobalt from the solution. The formula of this salt is $Co_2Cl_3 . 4NH_3+2HO$ or $\dot{C}o_2Cl_6 . 8NH_3+2\dot{H}_2$. It appears to be the chloride of the tetramin (octamin) series, the hyposulphate of which was discovered by Künzel and has the formula, $Co_2O_3 . 4NH_3 . 2S_2O_5$ or $\dot{C}o_2 . 8NH_3 . S_2\dot{O}_{13}$. Rose does not state whether the chloride combines or not with metallic chlorides, nor whether it yields other salts by double decomposition.—*Untersuchungen ueber ammoniakalische Kobalt-Verbindungen von Dr. F. Rose.* Heidelberg, 1871. W. G.

4. *On some new salts of roseo-cobalt and luteo-cobalt.*—Krok has studied a number of interesting salts of roseo-cobalt and luteo-cobalt in the laboratory of Blomstrand. The iodosulphate of luteo-cobalt, a yellow salt slightly soluble in hot and nearly insoluble in cold water, has the formula $\dot{C}o_2(NH_3)_{12}I_2(S\dot{O}_4)_2$. By evaporation with chlorhydric or nitric acid it yields the chloride or nitrate of luteo-cobalt. The corresponding chlorosulphate, $\dot{C}o_2(NH_3)_{12}Cl_2(S\dot{O}_4)_2+6$ aq, forms beautiful quadratic prisms, rarely octahedrons. Other salts of the same base have respectively the formulas,

$$\overset{vi}{\dot{C}}o_2(NH_3)_{12}\begin{cases}(Cl_2 . 2HgCl_2)\\(S\dot{O}_4)_2\end{cases} \quad \dot{C}o_2(NH_3)_{12}\begin{cases}Cl_2 . PtCl_2\\(S\dot{O}_4)_2\end{cases}$$

$$\dot{C}o_2(NH_3)_{12}\begin{cases}Cl_2 . 2HgCl_2\\Cl_4\end{cases} \quad \dot{C}o_2(NH_3)_{12}\begin{cases}I_4\dot{O}_{11}+2\text{ aq}\\Cl_4\end{cases}$$

The salts of roseo-cobalt obtained were:

$$\overset{vi}{\dot{C}}o_2(NH_3)_{10}I_2(S\dot{O}_4)_2+2\text{ aq}$$

$$\dot{C}o_2(NH_3)_{10}B_2(S\dot{O}_4)_2+2\text{ aq}$$

$$\dot{C}o_2(NH_3)_{10}Cl_6+2\text{ aq}$$

$$\dot{C}o_2(NH_3)_{10}(N\dot{O}_3)_6+2\text{ aq}$$

$$\dot{C}o_2(NH_3)_{10}Cl . S\dot{O}_4 . (S\dot{O}_4NH_4)'_3$$

$$\dot{C}o_2(NH_3)_{10}\overset{Cl_2 . 2HgCl_2}{(S\dot{O}_4)_2}+6\text{aq}$$

$$\dot{C}o_2(NH_3)_{10}\overset{(PtCl_4)''_2}{(N\dot{O}_3)_2}$$

$$\dot{C}o_2(NH_3)_{10}\overset{Cl_3 . 3HgCl_2}{(N\dot{O}_3)_3}$$

$$\dot{C}o_2(NH_3)_{10}Cl . (N\dot{O}_2)_5+3\text{ aq.}$$

They are not described in the letter from which this abstract is taken; the chloride and nitrate have long been known. The only salts of purpureo-cobalt mentioned are the well-known chloride and a chloroxalate, with the formula, $Co_2(NH_3)_{10}Cl_2(C_2O_4)_2$. This last salt was obtained by precipitating the chloride by ammonic oxalate.—*Berichte der Deutschen Chemischen Gesellschaft, Jahrgang* iv, p. 749. W. G.

5. *On the transformation of glucosides into monatomic and hexatomic alcohols.*—BOUCHARDAT has studied the action of an amalgam of sodium—in other words, of nascent hydrogen—upon glucose and milk-sugar. By the action of an amalgam, containing about 3% of sodium, upon glucose, the author obtained, together with a considerable quantity of mannite, an oily liquid containing common alcohol, C_2H_6O, isopropylic alcohol, C_6H_8O, and hexylic alcohol, $C_6H_{14}O$. This last is identical with the alcohol obtained by Erlenmeyer and Wanklyn from the iodide formed by distilling mannite or dulcite with iodhydric acid. The same volatile products were obtained from milk-sugar, but in place of mannite, dulcite was formed. By the hydrogenation of inverted milk-sugar, a mixture of dulcite and mannite was obtained.—*Comptes Rendus*, lxxiii, p. 1008. W. G.

II. GEOLOGY AND NATURAL HISTORY.

1. *Notice of a new species of Hadrosaurus;* by O. C. MARSH.—Among the Reptilian remains obtained by the Yale College party during the past summer was the greater part of a skeleton of a small *Hadrosaurus*, discovered by the writer in the blue Cretaceous shale near the Smoky Hill River, in Western Kansas. This species was somewhat smaller than *H. minor* Marsh, from New Jersey, and hardly more than one-third the bulk of *H. Foulkei* of Leidy. It was of more slender proportions, with the tail much elongated. The cervical vertebra are proportionally shorter than in *H. Foulkei*, and the caudals appear more compressed. Some of the distal caudals have a longitudinal ridge on the lateral surface. The sacrum, which is composed of six confluent vertebræ, is 414·mm· in length. The first caudal vertebra is 62·mm· in length. The feet are nearly entire, and are proportionally more slender than the known remains of the other species would indicate. The third metatarsal is 235·mm· in length, and 77·mm· in transverse diameter at its distal end. This species, which may be called *Hadrosaurus agilis*, will be fully described in this Journal at an early day.

Yale College, New Haven, March 19th, 1872.

2. *Corundum of North Carolina.*—Corundum has long been known to occur in Franklin, Macon Co., N. C., in large loose masses. Through the energy and labors of Col. C. W. JENKS, the masses have been traced up to their source, near by, in veins in the Blue Ridge, about 2500 feet above the sea level. Col. Jenks informs us that the main vein is four feet wide, and has a northeast course. It is made up of crystalline masses and crystals of the corundum, of

fine blue, grayish white and red colors, along with crystallized chlorite, and has a considerable thickness of the chlorite either side. The chlorite is supposed to be the *corundophilite* of Shepard, as the mineral to which this name was given came from masses of the corundum. There are six other veins, according to Col. Jenks: one of them is pure corundum; in others, it is associated with chlorite, or tourmaline, or feldspar, or mica. One chloritic vein has the chlorite packed with zircons; while another contains a greenish black variety of spinel, partly in disseminated grains, and partly in octahedral crystals, often grayish externally. In the mountain there are talcose or talcoid schists with some serpentine and several other minerals. The crystals of corundum are of all sizes from those of quite small size that are red and blue sapphires with good terminations, to others of gigantic dimensions, one prism weighing 300 pounds. These large masses are often fine in their red and blue colors.*

3. *Tusk of an Elephant or Mastodon found in Colorado.*—According to Capt. BERTHOUD, at the Patch or Hill diggings in the valley of Clear Creek five miles above Golden, and about one mile east of Guy gulch, he has recently discovered a portion of an elephant or mammoth tusk two feet eight inches long and eight inches in diameter, which in the ground sluicing of that placer was freed from its ten or fifteen feet of superincumbent gold-bearing gravel. This fragment of tusk lay some 25 feet above the bed of Clear Creek, and seems to have been brought to the position where found by glacial drift from a northwest course.

4. *United States Geological Surveys.*—A bill has passed the House in Illinois making liberal appropriations for the publication of the 5th volume of the Geological Report of the State, and it is confidently expected that the Senate will concur in it.

Dr. Newberry has asked from the Legislature for $10,000 to finish the Survey of Ohio and the Reports. The Legislature has not yet acted on the question, but a favorable result is expected. The good of the State and country will be promoted by the passage of the bill. The survey has been well carried forward under its able head, Prof. J. S. Newberry, and the Reports will be a highly valuable contribution to science.

A large appropriation is looked for from the Legislature of California for the continuation of the Survey of the State under Prof. J. D. Whitney and the printing of its Reports.

5. *Second Report of the Geological Survey of Indiana*, made during the year 1870, by E. T. Cox, State Geologist, assisted by Prof. JOHN COLLETT and Dr. G. M. LEVETTE. 304 pp. 8vo, with plates, maps and sections. Indianapolis, 1871.—This second Report of Prof. Cox is occupied mainly with details respecting the coal beds and the associated rocks especially of Sullivan, Davies and Martin counties, with notes also on some of the counties adjoining. There are also brief observations on the Quaternary and the various economical products of the counties, numer

* The veins are being opened by the American Corundum Co. of St. Louis, of which Col. Jenks is the "business manager."

ous analyses of coal by Dr. Levette, and general observations on the subdivisions of the coal formation of the State.

The chapter on Sullivan Co. is contributed by Prof. Collett. Speaking of the Quaternary of this county, he observes that the drift consists, in descending order, of blue and gray clays irregularly mixed with coarse and fine gravel; below these, the same clays with coarse gravel and boulders of granite, gneiss, quartzite, porphyry, with a very small quantity of gold, copper, lead ore, magnetic iron ore and red garnets; and at bottom, blue and white plastic clay two to five feet thick. The stratified material called "loess," stated to be next in time, contains at Fort Azatlan near Merom, a number of land shells, all of which are identical with existing species now living in the State, excepting *Helix occulta*, which has not been found living north of Arkansas.

Prof. Cox states that he is unable to find any ground for subdividing the coal formation into parts corresponding to separate epochs. He observes that there are two well defined zones of coal in the State, an eastern and a western. The area of the eastern is about 450 square miles; and the coals are of the free-burning or non-caking variety. The number of coal seams is eight; of these four are of good workable thickness over a portion of the field, making together fifteen feet. Adding six feet for the others it gives in all twenty-one feet of coal. Supposing one half this thickness to exist over the 450 square miles of area, it makes, as Prof. Cox says, the whole contents of coal to exceed five and a quarter millions of tons. The coal from this zone has received the name of *Block-Coal* on account of readily coming out in large blocks when mined. It breaks into thin sheets parallel with the bedding, but with difficulty in the opposite direction. The coal is remarkably free from sulphur and phosphorus, and is coming rapidly into use for the manufacture of Bessemer steel.

The western zone covers full 6,000 square miles, and contains three or more thick beds of good coal, which are in general caking-coals.

The Report closes with a list of the Plants of the State, by A. H. Young.

6. *Mines, Mills and Furnaces of the Pacific States and Territories;* by Rossiter W. Raymond, Ph.D., United States Commissioner of Mining Statistics. 8vo, pp. 556. New York: J. B. Ford and Company. 1871.—This volume forms the report of the Commissioner for the year 1870, and is issued by the publishers in advance of the congressional edition, which has only recently been ordered. It is the fifth report, in the series commenced in 1866, upon the condition and progress of mining industry in the Rocky Mountains and westward to the Pacific. In addition to the usual chapters of statistics of the production of the precious metals, this volume, like those which have preceded it, gives a great amount of valuable information upon the condition, resources and methods of the mining and metallurgical industry in California, Nevada, Montana, Arizona, and other important mining regions. We find, also, chapters upon metallurgical processes,

narrow gauge railways, mining law, the geographical distribution of metals and ores, the origin of gold dust and gold nuggets, etc., etc.

Incidentally to the descriptions of mining districts, a very considerable amount of information respecting the topography and the geology is given. This is true especially of the chapters upon the Territory of Arizona, which was visited by Dr. Raymond's assistant, Mr. Tilers. We find, for example, p. 230, the best description of the nature and extent of the great basaltic bed along the Gila river that has yet been given.

In the five chapters devoted to metallurgical processes, there is one upon the treatment of auriferous ores in Colorado, which includes a description in detail of the stamp batteries, and the arrangements for concentration. It is thorough and scientific, and is a valuable contribution to the literature of the mechanical treatment of ores. The only regret experienced in reading it is, that the same critical care and labor could not have been bestowed upon the superior mills and working in California. The chapter contains an elaborate discussion of the capacity, the wear and the product of stamps. The cost of gold extraction at steam mills is deduced as $3.74 per ton, including the interest on capital and the loss of quicksilver. Mr. Hague, in the volume upon Mining Industry, p. 555, makes the cost, exclusive of interest on capital, $3.69 per ton.

The total production of bullion gold and silver for 1870 is estimated at $66,000,000, of which California is supposed to have produced $25,000,000, and Nevada $16,000,000. Of quicksilver, the production was 29,546 flasks, being about 4000 flasks less than in 1869, and the price had advanced from 60 to 90 cents.

The volume, throughout, gives evidence of great labor and care in its preparation, and is a most acceptable addition to our knowledge of the mineral resources of the western portion of the country.

7. *Geology of Oxford and the Valley of the Thames;* by JOHN PHILLIPS, M.A., F.R.S., etc., Prof. Geol. in the University of Oxford.—Professor Phillips, one of the best geologists of Great Britain, has done a great service to general geology in the preparation of this work on Oxford geology. The rocks of nearly the whole geological series exist within the region described, or upon its borders, and the work consequently has nearly the comprehensive character of a general treatise on the science. Moreover, it is written in an attractive style, and illustrated with a very large number of cuts of fossils and sections, besides a colored geological map. The Malvern Hills, forming part of the boundary of the district, are claimed to be the oldest rocks of England—as old as any in Scotland—and the representatives, therefore, of the Laurentian of North America. The next rocks described are the Cambrian (now proved to be Primordial) and the rest of the Lower Silurian, which occur in the Malvern region. The larger part of the volume is taken up with the lias and oölite, and in this

part especially the work contains the results of much original investigation. The great Ceteosaurus is described in detail, and with many new facts and figures; and the other British reptiles of the period are well illustrated. The volume should be in the hands of every teacher of geology, and of all who have special interest in the science. Moreover it is a model for a treatise of the kind.

8. *Papers on the Eastern and Northern Extension of the Gulf Stream.*—From the German of Dr. A. PETERMANN, Dr. W. VON FREEDEN and Dr. A. MUHNY. Translated, in the United States Hydrographic office, in charge of Captain R. H. Wyman, U. S. N., by E. R. Knorr. 388 pp. 4to. Washington, 1871.—The Bureau of Navigation in this translation has made accessible to English readers several valuable memoirs by European geographers and explorers. The subjects of the Gulf Stream, the circumpolar currents, and the temperature of the Arctic are treated at length, with a full presentation of facts from all sources. The volume contains two colored maps, one giving the course of the Gulf Stream and the oceanic temperature north of latitude 35° in July, and the other the same in January, with also the temperature lines over Europe and part of Asia.

9. *Corals and Coral Islands;* by JAMES D. DANA. 398 pp. large 8vo. with several maps and numerous illustrations. New York, 1872. (Dodd & Mead, 762 Broadway).—This work is a general treatise on coral animals, and on the structure and origin of coral reefs and islands. It is based on the report on Zoöphytes published by the author in connection with the Wilkes Exploring Expedition, and a chapter of one hundred and fifty pages on Coral Reefs and Islands in the author's Geological Report of the same Expedition. Over one hundred pages are devoted to the subject of polyps and coral animals, their structure, habits, coral secretions, their classification, geographical distribution, etc., and many figures of corals, some of them of living corals, are given. The frontispiece contains colored figures of species of Actiniæ or Sea-Anemones, from the author's Report on Zoöphytes.

The following two hundred and fifty pages are occupied with a description of the structure of reefs and islands, a discussion of the origin of their peculiar forms and conditions and the rate of growth of reefs, an account of the completed atoll, notes on the geographical distribution of reefs, a survey of the proofs of elevation and subsidence over the Pacific derived from coral reefs and islands, and a chapter of geological conclusions from the facts of the volume. In an appendix the accepted names of all the species figured in the author's Report on Zoöphytes are given in a table prepared by Prof. Verrill.

The volume is printed in an unusually handsome style. The illustrations add much to its beauty.

10. *Report of the Geological Survey of the State of New Hampshire*, showing its progress during the year, 1870, by C. H. HITCHCOCK, Ph.D., State Geologist, Prof. Geol. and Min. in Dartmouth

College. 82 pp. 8vo. 1871.—This report contains brief notes on some of the rocks of the State, but is occupied mainly with the meteorological observations and other records made during the "Mount Washington Expedition" in the winter of 1870–1871.

11. *Report of the Geological Survey of Wisconsin;* by JOHN MURRISH, Commissioner of the Survey of the Lead District. Addressed to the Governor of the State, and submitted with the Governor's message, Jan. 11, 1872. This report is evidently the work of no regular State geologist. It is a trashy document, miserable in the most of its science, and often bad grammatically.

12. *Annual Report of the State Geologist of New Jersey for the year* 1871. 46 pp. 8vo.—Prof. G. H. COOK, State Geologist, here presents briefly facts connected with the economical geology of the State.

13. *Das Elbthalgebirge in Sachsen* von Dr. HANNS BRUNO GEINITZ. Erster Theil. Der untere Quader. III. Seeigel, Seesterne und Haarsterne des unteren Quaders und unteren Pläners. Mit tafeln 14–23. This continuation of Prof. Geinitz's fine work on the Elbe valley geology, contains descriptions, as the title page mentions, of the fossil Echinoids, Asterioids and Comatulids with, ten plates of excellent crowded figures.

14. *Scheutz, Prodromus Monographiæ Georum.* (Ann. Act. Upsal, 1870.) pp. 69, 4to.—Fischer and Meyer, and later C. A. Meyer himself, have attempted to put the genus *Geum* in order, and it is now the subject of a very careful monograph by a young botanist of the Upsal school, working under the eye of the veteran Fries. The genus is here received in the widest sense, as including both *Stylipus* and *Sieversia.* The North American species admitted are:

G. Virginianum L. and *G. album* Gmelin, characterized as we now understand them, but with more absoluteness than is found to prevail here where they grow. To the latter Scheutz inclines to refer Walter's *G. Carolinianum.* From the character there is hardly a doubt of it, and Walter's name is much older than Gmelin's.

G. Oregonense Scheutz is a new "sub-species" under *G. urbanum* (otherwise recognized only from the Old World): it is described from a specimen in the Stockholm herbarium collected by Wærngren; nothing of the sort from Oregon has fallen under our notice.

G. strictum Ait. Its extension into Corea and Japan is not referred to. The Scandinavian *G. hispidum* of Fries, admitted as a distinct species, seems too like *G. strictum.*

G. Japonicum Thunberg. To this, on the authority of Thunberg's specimens, *G. macrophyllum* Willd, is referred. Our two Japanese specimens (Oldham's, and one from the Leyden herbarium) have neither radical leaves nor mature fruit; they accord with Thunberg's character, and their rounder, scarcely lobed cauline leaves, and soft close pubescence or tomentum of the peduncles and upper part of the stems (quite at variance with "tota planta hirsutissima"), leave one dissatisfied with the identification.

G. agrimonioides (Pursh ?) C. A. Meyer. As to Pursh's plant, Scheutz has overlooked the positive affirmation in Torr. and Gray Flora, that it is *Potentilla arguta*, as was long before suspected by Torrey. Scheutz has no authentic materials of this, but describes from a specimen cultivated in the Upsal Garden, which accords with Meyer's description. The latter describes a specimen received from New York, in flower only, of which the petals are said to be "alba, vel ochroleuca, certe non aurea," three lines long and two wide, oval, and rather shorter than the calyx. We have no white flowered species with densely pubescent receptacle, which is the special character of *G. strictum*, and none of the latter with petals oval instead of orbicular, and rather shorter than the calyx. Meyer's plant lies between *G. strictum* and *G album* or *Virginianum*. It is to be noted that there is a Geum in Pennsylvania, Ohio, &c., with greenish-yellow or yellow petals, but with the receptacle and mainly the other characters of *G. album*. This we have once referred to *G. urbanum* L., and the question is whether *G. album* altogether should not be so referred, as is intimated in the last edition of the Manual.

G. rivale L. and *G. geniculatum* Michx., our only *Caryophyllata*. The latter, we still presume, was not found in Canada.

G. glaciale Adams, *G. triflorum* Pursh (to which his *G. ciliatum* is also referred), and *G. anemonides* Willd. (the first and last barely reaching our northwestern shores), are the *Sieversiæ* with plumose styles.

G. radiatum Michx. and *G. Peckii* Pursh (regarded as distinct, but surely without grounds), of the east; and *G. rotundifolium* Langsd. and *G. calthifolium* Menzies (probably not distinct), of the northwest coast, are our round-leaved *Sieversiæ* with styles naked above.

G. Rossii Seringe has styles wholly naked, and the pinnate foliage of *G. triflorum*.

G. vernum Torr. and Gray, the *Stylipus vernus* Raf., our author is much disposed to rehabilitate as a genus. A. G.

14. *Baillon, Histoire des Plantes* (Hachette & Cie, Paris).—The parts which have appeared during the year 1871 are numerous and important, and show a disposition to push on this work rapidly. Besides those noticed in our December number, we have now before us the monograph of *Papaveraceæ* and *Capparidaceæ*.

Following his extreme bent for combination, Baillon not only ranks the *Fumariaceæ* as a mere tribe of *Papaveraceæ*, but combines *Hunnemannia* with *Eschscholtzia* (yet, singularly enough, he keeps *Adlumia* distinct from *Dicentra*), reduces all Cleomeous genera to *Cleome* and *Wislizenia*, in place of nine genera admitted by Bentham and Hooker, and finally, though somewhat dubiously, appends *Moringa* to the order.

In the next monograph, that of *Cruciferæ*, we were curious to know what course would be followed in a strictly monotypical order, rather expecting that the 170 genera which Hooker and Bentham admitted might be reduced to a moiety; but he has cut short only ten, and, in fact, has followed his predecessors somewhat literally.

In the monograph of *Resedaceæ* there is no novelty to report. In *Crassulaceæ* only seven genera are left, *Penthorum* being transferred to *Saxifragaceæ*, *Tillæa* as well as *Rochea* to *Crassula*, and *Diamorpha* reunited to *Sedum*.

Saxifragaceæ are more remarkably treated. The order,—widened beyond all former limits by Bentham and Hooker, who included the *Francoeæ*, *Brexieæ*, the *Grossularieæ* and *Cephalotus*,—is now to comprehend, 1. *Penthorum*, to which no particular objection need be made; 2. *Pterostemon*, with seeds at length determined to be copiously abuminous; 3. the *Pittosporeæ*; 4. the *Bruniaceæ*; 5. the *Hamamelideæ*; 6. *Liquidambar* and its allied *Bucklandia*; 7. *Platanus*; 8. *Myosurandra* and another genus, trees of Madagascar, of which we know nothing; and, 9, with a saving mark of doubt, the *Datisceæ*. As to number of genera there is not much reduction. How such a family group is to be characterized, or why the author stops where he does, is not for us to say.

Piperaceæ constitute the next monograph, and are made bodily to include, not only the *Saurureæ*, but the *Chlorantheæ*, and *Ceratophyllum* as an appendage; the genera nearly as in a recent volume of the Prodromus. In *Urticaceæ*, the order is taken in the strict sense, and Weddell is quite implicitly followed. A. G.

III. Astronomy.

1. *On the Eclipse of the Sun on September 29th*, 1875; by Robert Treat Paine.* (Communicated to this Journal.)—In the remainder of this century there will be, in that large part of the United States north of North Carolina and east of the Mississippi, only one central eclipse of the sun, viz., the one which will be annular, in part of the State of New York and of four of the New England States, soon after sunrise on Wednesday, September 29th, 1875.

In the list of all the eclipses of the sun, visible at Boston, from 1824 to 1901, computed in 1823, by the solar and lunar tables then used, and published in the American Almanac for 1831, this eclipse is thus mentioned:

1875 Sept. 29th, Sun rises three-fifths eclipsed	5^h	56^m	30^s	mean time.
Formation of the ring,	6	20	21	"
Rupture of the ring,	6	22	52	"
End of the eclipse,	7	30	43	"

With the aid of the English Nautical Almanac for 1875 (in which the places of the sun and moon are given according to the recent and more accurate tables of Le Verrier and Hansen), this eclipse has been lately recomputed for lat. 42° 22′ 48″, long. 71° 7′ 40″, and will take place as follows:

* Mr. Paine states in a note to the editors:—My list of *all* the solar eclipses at Boston between 1824 and 1901, was computed in 1823 (the year after leaving college) when in my 19th year. It contains 30 eclipses, of which 20 have taken place, all of which but two, I think, I have observed; four of them (Feb. 1831; Sept., 1838; May, 1854, and Oct., 1865); *annular*, at Chatham, C. C.; Washington; Middlebury, Vt.; and Charleston, S. C. and two *total:* (Nov. 30th, 1834 and August 7th, 1869), at Beaufort, S. C.; and Boonesboro, Iowa; and I have begun to hope it is not impossible that I may observe here. the annular one of Sept., 1875, and at *Denver*, Colorado, the total one on July 29th, 1878.

Formation of the ring,	6^h	21^m	$22^s{\cdot}7$	A. M.
Least distance of centers of ☉ and ☽,	6	22	37 ·0	"
Rupture of the ring,	6	23	51 ·5	"
End of the eclipse,	7	32	35· 4	"

Least apparent distance of centers 29″·64, difference of semi-diameters 45″·78, do. of apparent latitudes, moon north, 29″·35.

The *central* eclipse will begin on the earth at sunrise, in lat. 43¼°, long. 77°, or near *Oswego*, in New York, and taking an E. by S. direction will reach the ocean at $6^h\ 24^m\ 2{\cdot}5^s$ *local* or at $11^h\ 7^m\ 22{\cdot}8^s$ Greenwich time, in *Salisbury*, in the northeastern extremity of Massachusetts, in lat. 42° 52 57″, long. 70° 50′ 5″; it thence passes in an E.S.E. course across the Atlantic, reaching Africa in lat. 17° N. long. 16° W. near Cape Verd, and leaving the earth at sunset, having occupied $3^h\ 41\frac{1}{2}^m$ in crossing it, in lat. 15° south, long. 46° east, in the island of Madagascar. The duration of the ring where longest will be $3^m\ 39^s$, but in *Salisbury*, Mass., and the adjacent town of *Seabrook*, N. H., $3^m\ 17{\cdot}2^s$.

The distance between the northern and southern limits of the annular eclipse in New York and New England will be about 110 miles, and a line drawn on a map, from Watertown, N. Y. about five miles south of Middlebury, Vt., and three south of Portland, Me., will represent very nearly the *northern* limit, and another drawn five miles north of Ithaca and of Hudson, N. Y., over Hadley, Franklin, Duxbury and Truro, Mass., the *southern*. Between these lines are included a large part of central New York east of Cayuga county, three quarters of Massachusetts, the southern half of Vermont and New Hampshire, and the southwestern extremity of York and part of Cumberland counties, Maine; also *five* astronomical observatories, viz: those of Hamilton College near Utica, and at Albany, in New York, at Harvard University and Amherst College, Mass., and at Dartmouth College, New Hampshire; but the eclipse will not be annular at Vassar College, Poughkeepsie, in any part of Connecticut or Rhode Island, at Springfield, Fall River or New Bedford, Mass., Middlebury, Vt., or Portland, Maine; at the last city, however, in lat. 43° 39′ 54″, long. 70° 14′ 34″, the least distance of the centers, 47″·62, will exceed the difference of the semi-diameters 45″·61, by two seconds only.

Since the magnificent total eclipse of five minutes duration, at Boston and Albany, near noon of June 16th, 1806, there have been in New England only two central eclipses, both annular in Massachusetts, viz., on February 12th, 1831, in Nantucket and Barnstable counties, and the second on May 26th, 1854, in a large part of New York, and of the same New England States as the one above described, and which at its next return on the 6th of June next will be annular at the city of Madras, etc., in India. When another central eclipse will occur in the northeastern part of the United States, has not, it is believed, yet been ascertained. But in more distant parts of our extensive territory or its vicinity, there will take place, according to the list computed in 1823, before mentioned, the following central eclipses within the next 29 years:

1876, March 25th, a central eclipse near noon, in part of Vancouver's Island and of British Columbia, probably total there a very few seconds, but generally annular, where the altitude of the moon will be less.

1878, July 29th, the great eclipse of June 16th, 1806, will return for the fourth time, and the shadow of the moon will pass over British Columbia, Montana, Colorado, Texas, Cuba, the city of Havana, etc. At *Denver*, Colorado, at about 3½ P. M., the eclipse will be total nearly three minutes, so that for careful observations on this eclipse Denver appears to be very favorably situated.

1885, March 16th, the eclipse of Feb. 12th, 1831, will return the third time, and be annular in the northern part of California and in Montana.

1900, May 28th, a total eclipse of the sun in the southern States, and the shadow of the moon, coming from the southwest, will reach the ocean in North Carolina, a little south of Norfolk, but the duration of totality will not exceed a minute at any place in the United States, where the eclipse is central.

Boston, February, 1872.

2. *Solar eclipse of Dec.* 12. *Observations made at Bekul by* J. P. MACLEAR, dated S. S. Indus, Jan. 6, 1872.—* * * The morning dawned bright and clear, only a few small clouds to be seen near the western horizon, a light breeze from the N.E. All were early at their stations watching anxiously the appearance of the sun, which rose over the distant hills about half-an-hour before the commencement of the eclipse. But now I shall speak only of my own observations; Mr. Lockyer has already given the account of those made by himself.

The instrument I used was a double equatorial of two 6-inch refractors mounted on the same base, one at either end of the declination axis. To one was attached a 6-prism spectroscope from Kew, lent by Mr. Spottiswoode, of great dispersive power. To the other was fixed a spindle bar, carrying an erecting eye-piece, and a 7-prism direct vision spectroscope, either of which could be swung at pleasure into the focus of the object glass; the two tubes had been carefully made parallel, so that the same object was viewed in both telescopes. The 6-prism was worked nearly the whole of the time by myself, and the direct vision by Mr. Pringle, who had practised with it constantly during the last few days. I add the observations made by him. At the commencement of the eclipse the slit of the 6-prism was placed tangential to the point of contact, that of the direct vision radial, width such that the absorption lines were very distinct, but not too fine. No change was observed from the ordinary solar spectrum. Keeping the slit for the next quarter of an hour tangential to the northern cusp, C was very bright the whole length; F bright, but thin. The slit was then placed radial to the cusp, and four bright lines near C (besides C itself) became visible, one on the direct side within 10 units Kirchhoff, and three on the red side within 20 units, the length of all five varying, but not together, the average being about one-eighth the height the visible spectrum.

At 6h. 51m. M. T., twenty-five minutes after contact, on a large prominence, C lengthened to half height of spectrum; nine minutes afterwards cusp was at another prominence; the positions of these must have been about N. 13°, and nearly north.

At 7h. 8m. M.T. I watched with the direct vision radial, and, besides the hydrogen and "near D" lines, observed another bright line a little more refrangible than the air band between *b* and F. At 1830 Kirchhoff it was very faint, and soon disappeared; soon after this I saw F line double about the same height as usual, one-eighth spectrum.

At 7h. 23m. M. T., having returned to the 6-prism radial to the cusp, I observed the hydrogen D, E and *b* very plain; several lines then began to come into view, as near as I could judge all the iron lines from halfway between D and E to beyond *b*. These kept on brightening and more lines coming in. I called Mr. Lockyer to look at the phenomenon, and we watched it together for two or three minutes until it became time to take position to observe totality. During these two or three minutes the cusp must have passed from about N. 38° E. to N. 70° E. or farther, and the lines were not lost sight of till I moved the telescope and placed the slit tangential to the point where the light would disappear, keeping it there with R.A. movement. On looking through the spectroscope the field was full of bright lines, the light just enough to let me distinguish the positions from the well-known solar lines.

As totality came on the light decreased, and the lines increased exceedingly rapidly in number and brightness, until it seemed as if every line in the solar spectrum was reversed; then they vanished, not instantly, but so quickly that I could not make out the order of their going, except that the hydrogen D, *b*, and some others between D and *b*, remained last. Then they vanished, and all was darkness. I then unclamped, and swept out right and left, but saw nothing; then went to the direct vision, but saw nothing; placed the telescope on the moon's limb by the eye-piece, then put in the spectroscope, but the light was not sufficient to show any spectrum; pointed the telescope carefully, first on the dark moon, and then on a bright part of the corona, but no spectrum. I then looked at the corona with the naked eye, saw a bright glory around the moon, stellar form, six-pointed, something like the nimbus painted round a saint's head, extending to a diameter and a half. Looked through the finder, and saw the same form, but very much reduced in size and brilliancy; then examined with the 6in. and eye-piece, and saw nothing but a bright glow round the moon, not much more than the height of the big prominence plainly visible in the S.E. quarter. The last thirty seconds had now arrived, and, as previously arranged, Mr. Lockyer took my place at the 6in., while I again looked through the 6-prism spectroscope to record anything that might be visible, but I saw nothing. As the spectroscope was not on the sun's limb at the re-appearance of the light, I cannot state what took place.

During the remainder of the partial eclipse I watched the northern cusp as the moon uncovered the sun, and several times I saw

distinctly the four bright lines near C; but saw nothing else worth recording.

The color of the corona appeared to me a light pinkish white, very brilliant. I saw no streamers. The rest of the sky and everything around had a bluish tinge. * * *.—*Nature, Jan.* 18.

3. *The Solar Eclipse of Dec.* 12. *Observations made at Poodocottah;* by L. RESPIGHI.—The spectral observations of recent total eclipses of the sun had plainly demonstrated the existence of an incandescent gaseous stratum or atmosphere, surmounting the chromosphere or stratum of hydrogen which envelops the body of the sun, but they had not sufficed to determine its true conformation and extent. This question, therefore, constituted one of the principal problems remaining to be solved by observations of the eclipse of the 12th of December, 1871.

The slit-spectroscope applied to large telescopes doubtless affords the best means of verifying the existence, in the circumsolar regions, of this gaseous stratum, which may be termed the superior chromosphere, and of determining the materials of which it is composed; but from the shortness of the time available in an eclipse, the spectroscope can furnish only partial and local results, insufficient, therefore, to reveal the true structure, form, and dimensions of this upper chromosphere.

Preceding observations having shown that the light of the solar corona is composed for the most part of a small number of elementary rays differing considerably in refrangibility, it appeared to me that the form and dimensions of the higher chromosphere might be much more conveniently studied by means of a large prism fixed in front of the object-glass of the telescope, whereby the several chromatic images of the corona would be distinctly formed in the focal plane. If the prism has but little dispersive power, and the eye-piece does not magnify too much, all the chromatic images of the corona may in this manner be observed simultaneously in the same field, and their form and dimensions directly investigated.

Towards the end of the year 1868, a small flint-glass prism was made for me by Signor Merz, of Monaco, to be fitted to the object-glass of the equatorial belonging to the Observatory of Campodoglio, for observations on the spectra of the stars; and this apparatus, in consequence of the dispersion of the prism, and the goodness of this prism and of the object-glass, was found to be admirably adapted for observing the eclipse in the manner just described.

The dispersion of the prism from the lines C to H of Fraunhofer is about 32′; the free aperture of the object-glass is $4\frac{1}{8}$ French inches; the field of the telescope is about 1°, with a magnifying power of 40.

My conviction of the great advantages which would be afforded by this instrument in the observation of the approaching eclipse, induced me to carry it to India for that purpose; and I was glad to learn that Mr. Lockyer, the chief of the expedition, had in like manner resolved to observe the corona by means of a spectroscope without a slit, being persuaded that this would be the most con

venient method of solving the questions relating to the corona itself. With this instrument, then, I prepared to observe the eclipse, proposing to myself the following problems:—

1. To ascertain whether, just before the beginning, and at the end of totality, the solar spectral lines are reversed—a phenomenon observed by Prof. Young in the eclipse of 1870.

2. Amidst the several chromatic images of the prominences, to observe especially whether the image given by the yellow line D_3 coincides with that of the lines of hydrogen gas.

3. To define the form and dimensions of the chromatic images of the corona. * * *

To verify the phenomenon of the reversal of the spectral lines at the extreme edge of the sun, I had arranged the plane of dispersion at right angles to the edge at the point of second contact.

At thirty seconds before totality, the spectral image of the luminous crescent was already sufficiently weakened to allow of its observation by the naked eye without a dark glass; and it was then that the principal dark lines of the solar spectrum came out distinct, and even more strongly marked than before, and curved parallel to the bright edge of the sun; but a few seconds before totality these lines disappeared completely, and the spectrum became continuous, without however exhibiting, just before totality, the reversal of the lines, although I was watching most intently for this phenomenon. I would not, however, be understood as denying altogether the reversal of the lines, for it is not impossible that a thin film of mist, or the bright atmospheric light at that time diffused over the spectrum of the solar limb, may have concealed the bright lines.

At the very instant of totality, the field of the telescope exhibited a most astonishing spectacle. The chromosphere at the edge, which was the last to be eclipsed—surmounted for a space of about 50° by two groups of prominences, one on the right, the other on the left, of the point of contact—was reproduced in the four spectral lines, C, D^3, F and G, with extraordinary intensity of light and the most surprising contrast of the brightest colors, so that the four spectral images could be directly compared and their minutest differences easily made out.

In consequence of the achromatism of the object-glass, all these images were well defined, and projected in certain colored zones, with the tints of the chromatic images of the corona. My attention was mainly directed to the comparison of the forms of the prominences on the four spectral lines; and I was able to determine that the fundamental form, the skeleton or trunk, and the principal branches, were faithfully reproduced or indicated in the images, their extent being, however, greatest in the red, and diminishing successively in the other colors down to the line G, on which the trunk alone was reproduced. In none of the prominences thus compared was I able to distinguish, in the yellow image D^3, parts or branches not contained in the red image C.

Meanwhile the colored zones of the corona became continually more strongly marked, one in the red corresponding with the line C, another in the green, probably coinciding with the line

1474 of Kirchhoff's scale, and a third in the blue, perhaps coinciding with F.

The green zone surrounding the disc of the moon was the brightest, the most uniform, and the best defined. The red zone was also very distinct and well defined, while the blue zone was faint and indistinct. The green zone was well defined at the summit, though less bright than at the base; its form was sensibly circular and its height about 6′ or 7′. The red zone exhibited the same form and approximately the same height as the green, but its light was weaker and less uniform. The height of the green zone was estimated by comparison with the moon's diameter, and from the observed distance of the spectral lines of the prominences.

These colored zones shone out upon a faintly illuminated ground, without any marked trace of color. If the corona contained rays of any other kind, their intensity must have been so feeble that they were merged in the general illumination of the field.

Soon after the middle of the total eclipse, there appeared on the eastern limb, at about 110° from the north point, a fine group of prominences formed of jets rather low but very bright, some rectilinear, others curved round the sun's limb, and exhibiting the intricate deviations and all the characters of prominences in the neighborhood of solar spots. The brightness and color of these jets were so vivid as to give them the appearance of fire-works.

The spaces between some of these jets were perfectly dark, so that the red zone of the corona appeared to be entirely wanting there. Perhaps, however, this was only an effect of contrast due to the extraordinary brightness of the neighboring jets. I have thought it right to refer to this peculiarity, because the appearance of interstices, or dark spaces, between prominences of considerable brightness, is often observed by means of the spectroscope, independently of total eclipses.

The want of an assistant to note the time, and to write down the observations as they were made, occasioned me some loss of time, and the end of the total eclipse was already at hand before I was aware of it.

The green and red zones were well developed at the western as at the eastern limb, while the blue remained faint and ill-defined.

Soon after the appearance of the chromosphere at the western edge, there was suddenly projected on the spectrum of the sun's limb, which then appeared beyond that of the moon, a stratum of bright lines, separated by dark spaces; but I could not determine whether they were due to a general or partial reversal of the spectral solar lines, or to a simple discontinuity in the spectrum, since they were too soon immersed in a flood of light, which put an end to the totality of the eclipse. * * *—*Nature*, *Jan.* 25.

4. *Prof. Young on the results of the Eclipse observations.*—In an article in the Boston Journal of Chemistry, Prof. Young thus speaks of the results of the observations on the recent solar eclipse, in establishing his interesting discovery in 1870, of the reversal of the Fraunhofer lines in a stratum close to the sun:

"The reversal of the Fraunhofer lines seems to have been satisfactorily observed by Captain Maclear at Bekul, Colonel Tennant

at Dodabetta, and Captain Fyers at Jaffna. It was partially seen by Pringle at Bekul, and Respighi at Poodocottah, and probably by Pogson at Avenashi. How it was with Janssen I do not know. His instrument, however, on account of the small size of the sun's image, was not very well adapted for this observation.

Mosely, at Trincomalee, did not see it. Mr. Lockyer missed it by an accidental derangement of the telescope. He says further, 'At the last contact Mr. Pringle watched for it and saw no lines.' How the mistake occurred I do not understand, but Mr. Pringle's own words are, 'At the end of totality a considerable number of lines flashed in; what proportion of the whole I cannot say, perhaps one-third.'

Captain Maclear writes, 'As totality came on the light decreased, and the lines increased exceedingly rapidly in number and brightness, until it seemed as if every line in the solar spectrum was reversed; then they vanished, not instantly, but so rapidly that I could not make out the order of their going.'

This description applies exactly to what I saw in 1870, except that the lines then made their appearance more suddenly—they flashed out like the stars from a rocket head; but the discrepancy is easily enough accounted for by supposing that the portion of the sun's limb last covered by the moon was then more quiet than at the time of Captain Maclear's observations."

IV. Miscellaneous Scientific Intelligence.

1. *Correspondence relating to the Dismissal of the late Botanist to the Department of Agriculture.* Reprinted from the American Naturalist for January, 1872. 8 pages, 8vo.—In the pages of the Naturalist, and in this pamphlet, this case has been so far made known that we can well enough refer to it without reprinting the correspondence, although this indeed is not long. That the botanists of the country should have felt aggrieved by the treatment accorded to one of their number is natural, and some expression of their indignation might not have been out of place. But in the published correspondence they have confined themselves first to a respectful request to the Commissioner of Agriculture that he "would take into consideration the propriety of re-appointing Dr. Parry to the position of Botanist in the Department of Agriculture;" then, on receiving an unfavorable reply, to which the Commissioner gratuitously appended the intimation that were it not for his desire to spare Dr. Parry in the estimation of his friends, he could say something to Dr. Parry's disparagement, one of their number claimed to be informed as to the nature of the delinquency insinuated, and was accordingly "put in possession of the whole subject," in a reply from the Commissioner. and thereupon (permission asked and granted), the correspondence is printed, that it may speak for itself. Leaving the case to make its own impression upon the Commissioner's own showing, no comment was made beyond the following preface.

"Dr. Parry was thought to have performed the duties of Botanist to the Department of Agriculture to the entire satisfaction of

the previous Commissioner. His extraordinary abrupt dismissal upon the incoming of the present Commissioner, following a course of vexatious treatment to which, he states, he was subjected by his Chief Clerk, does not seem calculated to win the confidence of scientific men in the present administration of a department in which they naturally feel much interest."

The tenure of any appointment in a government office, with present usages, is precarious enough under ordinary circumstances; but here a scientific man is dismissed with far less notice and consideration than is due to a household servant. The Commissioner, just established in his office, writes to Dr. Parry, Sept. 27—"Sir: Your services as botanist of this department will not be required after this date;" and this letter is delivered at the close of the day.

Now, apart from the recognized official usages, there is one reason which might have suggested less precipitation in this instance. The Herbarium which Dr. Parry was in charge of, and was putting for the first time in order under instructions of the previous Commissioner, does not belong to the Agricultural Department, but is a part of the National Museum, of which the Smithsonian Institution is the legal, and was the actual custodian. The custody was transferred to the Agricultural Bureau under an arrangement between the Secretary of that Institution, and the late estimable and enlightened head of the Bureau (Gen. Capron)—who seems not to have thought an herbarium and an "herbarium botanist" "practically unimportant." And we understand that the Secretary of the Smithsonian Institution stipulated that the herbarium should be in the charge of some botanist acceptable to him, and should be put into proper order; and that Dr. Parry was appointed under his recommendation. It might have been expected, therefore, that if the Commissioner desired to make a change, or even thought a change necessary, he would have conferred with the Secretary of the Institution; while the delay of a week or two needful for doing so, would have allowed the incumbent he was superseding no more than the customary notice which the lowest clerk in a government office may expect to receive.

Evidently, this precipitate dismissal of his subordinate by the Commissioner, as it would seem to be justifiable only on the ground of gross misconduct of the former, so it would of itself seem to imply misconduct. And the Commissioner makes the implication explicit at the next stage of the proceedings, namely, in his reply to the memorial of the botanists who solicited a reconsideration, and that gratuitously, as the memorial does not ask for the reasons. When informed that they were of a nature "disagreeable to utter and likely to disparage Dr. Parry in the estimation of his friends," they were of course immediately asked for. The claim for them was responded to; and it only remains to consider what the reasons turn out to be.

First, the Commissioner, on taking possession of his office, "found that nothing at all had been done by Dr. Parry beyond his attention to the preservation of the herbarium." Without

stopping to enquire what more the Commissioner might have found if he had waited until more familiar with the work and duties which Dr. Parry had fulfilled under General Capron, it may be remarked that the "preservation" of the herbarium in this case means the whole arrangement, and in a good degree the formation of it, out of an accumulation of collections, in part unnamed, requiring long labor and much study; that this was obviously the first thing to be done, and Dr. Parry was specially appointed to do it; and that the herbarium was in the midst of removal to new quarters prepared for it when the work was thus summarily arrested.

Next, as to the investigations which the Commissioner would desire the botanist to undertake, "the principles of vegetable physiology, their relations to climate, soils, and the food of plants, and the diseases of plants, which are principally of fungoid origin," and the throwing of "some light upon the origin and condition of growth of the lower orders of cryptogamic botany;" it is clear that Dr. Parry could not yet have had much time for them: it is not said that he had been asked to undertake, or had shown any disposition to evade them; all that the Commissioner charges is, that "this is a domain into which I could not discover that Dr. Parry had ever entered, so far as his practical work here gave any indication." Thus far there is nothing to explain the urgent action resorted to.

The next charge is that there were letters written by Dr. Parry which the Commissioner "deemed objectionable because of his mode of expression, wanting in perspicuity and not creditable to the department." That is a matter somewhat of taste and opinion. We have read Dr. Parry's published reports and articles without noticing any deficiency in this regard. We have also read, with a sense of wonder and bewilderment, some published reports of the present Commissioner, one or two extracts from which are appended to the correspondence we are noticing. Such things it would hardly be worth while to notice, except by way of a demur to the Commissioner's judgment. If the want of perspicuity and good grammar is as urgently felt in the Agricultural Bureau, as it is practically illustrated, let these accomplishments be supplied at all hazards.*

The Commissioner's remaining specifications, detailed at some length, from all that we can learn, amount to this. While arranging the herbarium, Dr. Parry was in the habit of transmitting by mail occasional specimens to be examined by other botanists. Specimens were also sent to him for naming. The new Commissioner and his clerk appear to have suspected something wrong or irregular in this, and required that all notes accompanying such

* Yet it is hard to insist upon them, since, when sought at "any of the literary colleges," they are to be acquired at such fearful risk. The Commissioner declares —in one of the choice excerpts referred to—that "our experience teaches us, that a farmer's son, graduated in such an institution, finds no place, ever after, in the domestic circle of his family; *he is actually driven by his education* into the necessity of resorting to some neighboring town, in pursuit of a learned profession, *where he soon forms habits of idleness and intemperance.*"

enclosures, however trivial, should be strictly copied, and should receive the Commissioner's own signature. This was novel to the botanist, who could not at once see the sense of it in such little matters; it appears to have led to some bickering with the clerk, and this to a request for definite instructions on the point from the Commissioner himself. That the botanist should ask for "definite written instructions" was not unnatural when a new practice was thus pressed upon him, which he thought could hardly be meant to apply to such particulars; but he asks them in order that he may be enabled to comply strictly with the regulations of the department, and his letter appears to us respectful and proper, both in form and substance. That our readers may judge, we append a copy of it.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 27, 1871.

Hon. F. WATTS, *Commissioner of Agriculture.*

SIR:—In order to enable me to comply strictly with the regulations of this Department in regard to ordinary correspondence in connection with my official duties as botanist, I respectfully ask to be furnished with written instructions on the following points. 1st. Should letters addressed to me personally, as botanist of the department, imparting or requesting information on botanical subjects, be answered and signed by me personally as botanist, or in the name of the Commissioner? 2d. In sending botanical specimens to be named, or in returning such as have been sent to me to name, should the accompanying letter be signed by myself as botanist or by the Commissioner?

Having heretofore exercised my own discretion in this matter, with due regard to the scientific interests of the department and to facilitate the business of my division, I desire to avoid any future misunderstanding by receiving definite written instructions on these points for my guidance.

Respectfully yours,
C. C. PARRY, *Botanist Agr. Dpt.*

In the Commissioner's account of the matter he states: "I did not think that he [Dr. Parry] was in want of the information he asked for, and my answer to his note was that the Department did not longer require his services." The letter of dismissal, which, as an English scientific journal remarks, "may well stand as a model of epistolary curtness," we have already cited in full.

Here is the upshot of this petty and truly pitiful business. It is not pleasant to call attention to it. But if such be the treatment to which scientific men may be exposed upon entering the service of the Government, the more widely it is known, the sooner it may perhaps be amended. EDITORS.

2. *Spectrum Analysis in its application to Terrestrial Substances and the Physical Constitution of the Heavenly Bodies*, familiarly explained by Dr. H. SCHELLEN, Director der Realschule, I. O. Cologne, etc. Translated from the second enlarged and revised German edition by JANE and CAROLINE LASSELL. Edited, with notes, by WM. HUGGINS, LL.D., F.R.S. 662 pp. 8vo., with numerous woodcuts, colored plates, and Angström's and Kirchhoff's maps. London, 1872. (Longmans, Green & Co.)—Schellen's work on Spectrum Analysis has a high European reputation. It is excellent in all respects, in its paper and typography, its clear and thorough treatment of the subject, and its admirable illustrations, which are

numerous and include many colored spectra of the elements, others uncolored of the sun's spots, corona, etc., several of comets and stars, and many beautiful colored views of the protuberances of the sun. It contains also descriptions and figures of instruments and an account of the methods of observations, together with a list of the memoirs and works hitherto published on the subject.

3. *Kansas Academy of Science.*—This Academy is a State Society, and has no special location in the State. A list of the papers presented at the annual meetings in 1869 (the second), 1870 and 1871, is contained in the Eleventh Annual Report of the Department of Public Instruction of the State of Kansas, 1871. The papers on the plants of Kansas by J. H. Carruth mention 600 species, and one on the birds by F. H. Snow describes 164 species. Among the titles are those of geological papers by Prof. B. F. Mudge and J. D. Parker.

4. *Hunt's Green Mountain Series.*—In my notice of the address of Prof. Hunt, on page 93 of this volume, I speak of the Green Mountain series as including with small exceptions the Metamorphic rocks between the Connecticut River and Mesozoic on the east and the Green Mountain (Stockbridge and Eolian) limestone on the west. A correspondent observes that the exceptions are larger than is implied in the above expression. In order to give the facts correctly, I cite here the paragraphs from the Address bearing on the subject, although they do not affect the argument in my paper. Mr. Hunt says: "The rocks of the second [Green Mountain] series are traceable from southwestern Connecticut northward to the Green Mountains in Vermont; and the micaceous schists and gneisses of the third or White Mountain series are found both to the east and the west of the Mesozoic valley in Connecticut and Massachusetts. They also occupy a considerable area in eastern Vermont, where they are separated from the White Mountain range by an outcrop of rocks of the second series" He also says that certain gneisses in western Connecticut, defined by Percival (his K1 and K2), may prove to be Laurentian. The address contains nothing more definite on the subject. In his article on the Geology of New England, in this Journal, II, l, 83, he says with regard to the occurrence of the White Mountain series in Vermont: "I believe that much of the calcareous mica slate of Eastern Vermont will be found to belong to the Terranovan [White Mountain, as now designated by him] series." J. D. D.

OBITUARY.

Dr. Wm. Baird, of the British Museum, died on the 27th of January last. The *Standard* writes of him:—"In losing Dr. Baird, the British Museum has lost one of the most valuable members of its staff. Dr. Baird, who was born in Scotland in 1803, was educated at Edinburgh, Dublin, and Paris, for the medical profession, and served for some years as a surgeon in the naval service of the late East India Company. His voyages in this capacity gave him ample opportunities for the study of his favorite pursuit—zoology. In 1841 he accepted an appointment in the Zoological

Department of the British Museum, and this he retained up to the time of his death. His writings are chiefly to be found in periodicals; but his most important work was a 'Natural History of the British Entomostraca,' which was published under the auspices of the Ray Society in 1850. Subsequently Dr. Baird was elected a Fellow of the Royal Society. In private life he was greatly beloved, on account of the unvarying amiability of his disposition and the kindness of his manners." A writer, Mr. H. Lee, in *Land and Water*, for Feb. 3, adds, "Most heartily do we confirm the last preceding sentence. His store of knowledge, though freely at the service of all who desired to profit by it, was hidden under the quiet modesty of his demeanor; but the amiability of his disposition and the kindness of his manners were instantly apparent, even to a stranger who had the honor of an introduction to him. On those days when the Museum is closed to all but students, he was usually to be seen in the conchological gallery, bending over one or other of the table-cases, patiently and carefully arranging and examining specimens of shells; and so closely is he associated in our mind with the scene of his duties, that when in future we enter the gallery on such days, it will be long ere we cease to look instinctively, as of old, for the familiar blue skull-cap, and the gentle, placid face beneath it, and the kind, genial smile, and the cordial greeting of Dr. Baird. They can never more gladden and encourage us, but they will take and retain a place in the treasury of our pleasant recollections of good men whom it has been our privilege to know and appreciate."

W. Harper Pease died recently at Honolulu, where he had lived since 1853, collecting and studying the mollusca of the Hawaian seas and of Polynesia generally. During the Mexican war he made a large collection of birds, which were deposited with the Academy of Natural Sciences at Philadelphia, and among them were some new species, which were afterward described by Mr. Cassin.—X. in *Harper's Weekly*, Feb. 10.

Rev. Canon Moseley, F.R.S., author of papers on the freezing of ice and the movement of glaciers, died on the 20th of January last in his 71st year.

Dr. Adolph Strecker, the able Professor of Chemistry at Würzburg, has recently died.

Appendix to the Fifth edition of Dana's Mineralogy, by Prof. George J. Brush. 24 pp. 8vo. 1872. New York. (John Wiley & Son, Astor Place). Contains descriptions of eighty-seven minerals announced as new during the four years since the publication of the Mineralogy.

Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. V. The immature state of the Odonata, Part I. Sub-family Gomphina; by Lewis Cabot. 18 pp., with three plates. No. VI. Supplement to the Ophiuridæ and Astrophytidæ; by Theodore Lyman. 18 pp., with two plates.

Catalogue of the Principal Minerals of Colorado, with Annotations on the local peculiarities of several species; by J. Alden Smith. 16 pp. 8vo. Central City, Colorado, 1870.

Contributions to the Fauna of the New York Croton Water. Microscopical observations during the years 1870–71; by Charles F. Gissler. 22 pp., 8vo., with four plates. New York, 1872.

Department of the Interior

U.S. Geological Survey of the Territori

YELLOWSTONE NATIONAL P

From Surveys made under the directio

F.V. HAYDEN

U.S. Geologist

And other authorities

1871

111°

110°

West Gallatin River

YELLOWSTONE RIVER

Emigrant Peak 10629

Grand Canon

Hot Springs

Mt. Washburne 10578

Grand Canon

Lower Falls

Upper Falls

MADISON RIVER

Hot Springs

Hot Springs

ELEPHANT'S BACK

Hot Springs

Lower Geyser Basin

Upper Geyser Basin

YELLOWSTONE LAKE 7427

Hot Springs

Hot Springs

Hot Springs

DE LACY'S FORK

SNAKE RIVER

Upper Yellowstone River

Bridger's Lake

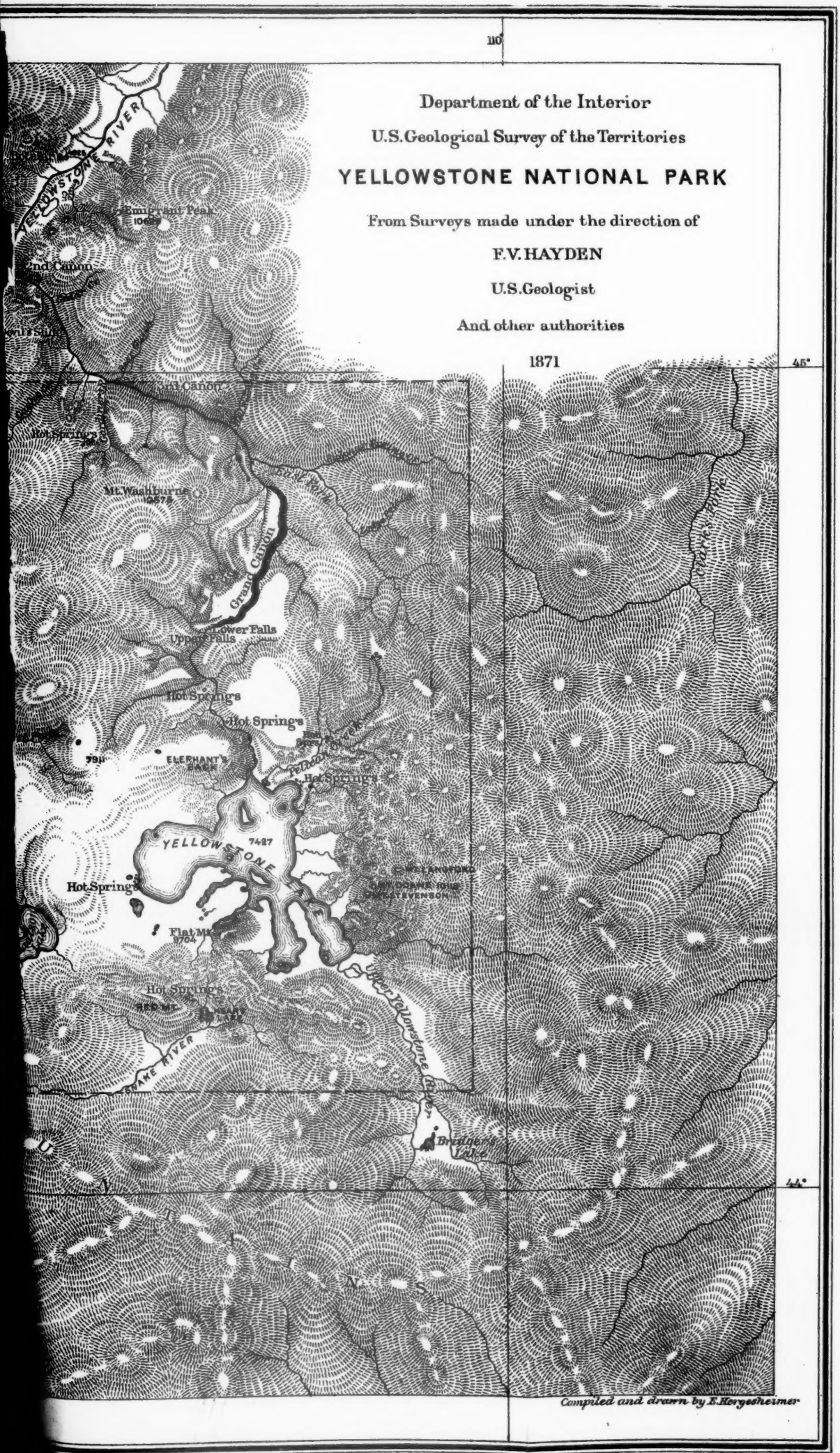
Elevations are in Feet above Sea Level

Boundary of Park — — —

Miles

10 5 0 10 20

Compiled and drawn


110°
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44°
Department of the Interior
U.S. Geological Survey of the Territories
YELLOWSTONE NATIONAL PARK
From Surveys made under the direction of
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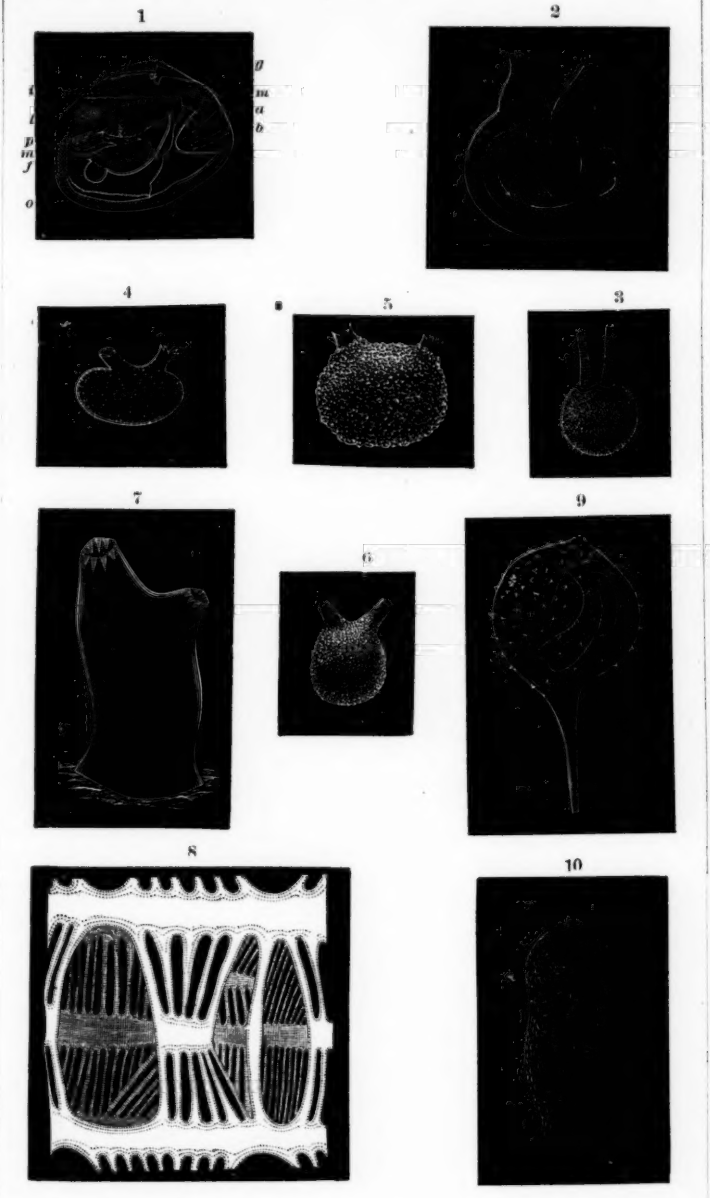
7911
YELLOWSTONE
7427
Flat Mt.
9704
RED MT.
SNAKE RIVER
Yellowstone Lake
Gallatin Range
Compiled and drawn by F. Herzesheimer
J. Bien, photo lith.



A. E. V., from nature.